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Current Teaching-Machine Programs and Programming Techniques

Joseph W. Rigney and
Edward B. Fry

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Current Teaching-Machine Programs and Programming Techniques

JOSEPH W. RIGNEY AND
EDWARD B. FRY

The bulk of the material in this report was prepared for the Personnel and Training Branch, Psychological Sciences Division, Office of Naval Research, by Electronics Personnel Research Group, Department of Psychology, University of Southern California. It appeared originally under the title, "A Survey and Analysis of Current Teaching-Machine Programs and Programming."

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PREFACE

This report is a survey of teaching-machine programs and programming techniques as they existed at the end of 1960. The original intention to sample literally every program in existence was soon recognized as impossible. Because of the rapid expansion of the programmed learning field, an exhaustive sample is out of date by the time it can be published. The 81 programs contained in Part II are those that were available to the authors at the time the survey was made. We believe they indicate something of the diversity of this new art.

The object of the report is to present an overview for the many individuals who have a need to know about programming and programs, but who are not working directly in the field. It is an interpretative and descriptive report rather than a survey of the research literature or of popular research issues. It describes the types of programs now available in terms of content and educational level. It defines some common terms in the field and summarizes some programming rules and techniques. It presents an outline of factors which suggest the complexity of the educational context in which programmed learning must find a place. And finally, it presents samples of 81 current programs.

—J. W. R. AND E. B. F.

PART I

Programming Techniques

AN ODD MIXTURE of commercialism, unrestrained enthusiasm, and sober research, the teaching-machine field continues to expand as psychologists, educators, training specialists, and engineers become involved one way or another with programmed learning. There are now lengthy programs for many traditional as well as more exotic areas of knowledge. As more of these programs become available and as more people venture into program writing, there will be a growing need for occasional overviews of programs and programming techniques. This report is intended to be just such a cross section.

This introductory section outlines briefly the general features of a teaching-machine program and describes two approaches to programmed learning. Subsequent sections contain a classification of programs by type and content and summarize information about how programs are produced. In the fourth section many factors relating to programming and programming research are presented in outline form to suggest the great complexity of the educational or training situation. Presented finally are samples of 81 teaching-machine programs which comprise approximately the last half of the report.

What is a Teaching-Machine Program?

There is some danger that the overworked word "program" will be confusing to the initiate in the field for it has connotations suggestive of a computer program. It would be interesting to draw an analogy between computer and teaching-machine programs, but there are basic differences.

A computer program is a long list of instructions to a general purpose electronic computer which causes it to perform certain arithmetical, logical, or housekeeping operations. A teaching-machine program has very little to do with control of a teaching machine. It is designed to present material to the learner and to control the student's behavior during his learning by exposing stimulus material, requiring some overt or covert response to this material and providing some form of knowledge of results for each response. It is a program in the sense that it is a list of items, steps, or frames, each of which performs these functions. The words *item, step,* and *frame* are used here more or less synonymously, although *frame* has a connotation of spatial dimensionality.

Most teaching-machine frames, then, are comprised of three elements: stimu-

lus, response, and feedback. The following example from a constructed-response type of program in introductory college mathematics illustrates the basic unit: [1]

> The sum of two numbers is a number.
> The sum of two expressions (stimulus element) is an _____ (response element).
>
> *expression* (answer or feedback)

The student is directed to read the stimulus element, he responds by filling in the blank with a word, and receives feedback by performing an operation which reveals the correct answer, "expression." There are 662 of these basic units in this particular program. Other programs contain several thousand such steps.

Aside from subject matter, the differences among teaching-machine programs are due in part to variations among these elements—these may be called intrastep differences. Other differences are due to their variations among or across steps—these can be called interstep variations. There are, for example, branching and nonbranching programs, programs with conversational chaining, programs which use vanishing, and so on. These terms represent particular interrelationships among successive steps which will be discussed later.

Approaches to Programmed Learning

Since there are a number of references covering the history of teaching machines (Galanter, 1959; Lumsdaine and Glaser, 1960) it is sufficient to say here that the fundamental idea—that of organizing subject matter into a sequence of easily understood, interdependent steps—probably is as old as man's attempt to educate himself. Any good textbook writer or teacher follows this principle at some level of detail. The developers of programmed learning greatly refined the idea by providing ways for the student to make sure that he understands each unit before proceeding to the next, by shifting the stimulus-response ratio toward much more frequent overt responding, and by adopting more specific models for a basic unit of material.

Pressey (1927) used the multiple-choice question format to this purpose; Skinner (1958) used the fill-in, or completion item, as basic model for those of his programs concerned with verbal learning. These two formats for a step persist in current programs. The larger proportion of them follow the constructed-response model; the remainder are multiple-choice programs, the majority of which are a special version called intrinsic programs (Crowder, 1960).

It will be convenient to label programs as either "constructed response" or "multiple choice" and to classify them into two groups on this basis. In so doing, there is no intent to imply that one approach is better than the other or that the only differences between the two are differences between selecting an alternative in a multiple-choice question and constructing a response for a completion or fill-in question. These differences between the two kinds of questions are relatively trivial, whereas the two approaches to programmed learning differ

[1] *Introduction to College Mathematics*, Encyclopaedia Britannica Films, Inc., 1960, p. 4, item 19. See Part II for further examples and information about this program.

profoundly in philosophy and procedure. The result is that it is difficult to compare the two methods. Intrinsic programming was originated by Crowder and is used primarily by him. However, the majority of programmers today follow Skinnerian procedures and philosophy.

Intrinsic programming (Crowder, 1960) is based on the philosophy that teaching is a communicating process, and that human learning takes place in a variety of ways depending on the abilities and knowledge of the students, the nature of the subject matter, and other factors, some perhaps even unknown. Therefore, the intrinsic programmer does not presume to know how to set up conditions under which efficient learning will inevitably occur. Instead, he uses feedback to control the communication process. The primary purpose of knowledge of results in this method is to determine whether the communication was successful. If it was not, corrective measures are taken. The student branches to explanatory material, to several successive steps which constitute a review, or to a remedial loop. Intrinsic programs necessarily are branching. To implement their variability, either a machine or a scrambled book is required.

In the "scrambled book," a unit of information (the stimulus element of the program step) is given on one page along with a multiple-choice question. Each choice is tagged with a different page number referring the student to an explanation of why a particular choice is right or wrong. On wrong choices, the student is usually told to return to the original question and try again. On correct choices he begins the next step after reading the feedback for the right choice. Thus, the elements of an intrinsic-program step are scattered over several pages. (Samples are given in Part II.)

Constructed-response programming was developed by Skinner (1954, 1958) from his work with operant conditioning. Briefly, the philosophy is that the student can be led to the desired terminal behavior through many successive steps, each reinforced by knowledge of results. The trick for the programmer is to discover the particular sequence of steps which will lead the student to the desired outcome with a minimum (but not necessarily zero) number of errors along the way. Knowledge of results is given to reinforce correct responses and to let the student know when he is wrong. In this type of programming it is extremely important to discover the right sequence of steps and to construct each step properly. The student's response to each step must be the result of attending to the critical information in the steps.

The aversive effects of error are considered to be serious. The approach requires that steps be written with very low difficulty level, so that the student will make very few errors. The technique emphasizes gradual progression from simple to complicated ideas or concepts and recommends that any particular rule, abstraction, or concept be reintroduced again and again, each time with a slightly different example or in a slightly different context. As Holland (1960a) puts it, this is because "an abstraction is a response to a single property of a stimulus and can only be established by presenting the full range of examples illustrating the abstraction and having all the irrelevant properties varied among the various presentations."

Program Types and Features

Of the 81 programs initially sampled in Part II, 62 are essentially of the constructed-response variety and 19 are multiple choice. Programs in the latter category have evolved in several directions from the simple model. The classic step format is illustrated by an item from one of the original Skinner programs: [2]

> Candy, put in the mouth of a child for the first time, _____ salivation.
>
> Answer: *elicits*

This item was intended for presentation by a machine which would not expose the correct answer until the subject had constructed a response. Other programmers (Homme and Glaser, 1959) have discounted the importance of this feature and are providing the answers in a fashion that makes them accessible to the student before he responds. Thus, if he wishes to, he may look ahead in the program. The programmed text is an example of this. A step from a programmed text is presented below: [3]

> We might expect alternate light and dark bands if we alternatively had constructive and _____ interferences produced by the combining of two sets of light _____.
>
> Answers: *destructive . . . waves*

[2] *A Self-Tutoring Introduction to a Science of Behavior*, Psychological Laboratories, Harvard University, 1960, Lesson B-1, Panel I.

[3] *High School Physics, Vol. 2*. David Klaus, American Institute for Research, 1960, p. 261, item C-590. See Part II for further examples and information about this program.

In the programmed text, the stimulus and response elements of a step are presented on one page and the feedback element on the following page. This format makes it possible to use a simple paper-and-pencil device as the vehicle for the program.

Some constructed-response programs also contain multiple-choice steps or paragraphs of text. Table I summarizes the category as a whole in terms of subject matter and level of instruction.

A number of programming techniques, or variations, exist which require brief descriptions. Of these, prompting, cueing, and vanishing are commonly used. Following are a brief description and illustration of each:

Conversational Chaining: As shown in the illustration below, the answer for a step in this technique appears in capital letters in the stimulus element of the next step. This procedure has been used by Barlow (1960).

> 1. The more things we have to choose from, the greater the freedom of _____ we have.
>
> 2. The amount of CHOICE is dependent on the number of alternatives available and upon whether or not we have any _____ of alternatives.
>
> 3. KNOWLEDGE increases both the number of alternatives and the amount of information one has to help him make up his _____.
>
> (*Note:* The answer to item 3 above appears in capital letters with the next item in this program.)

TABLE 1—SUMMARY OF CONSTRUCTED-RESPONSE PROGRAMS

Subject Matter	*Level of Instruction* *				*Total No. of Programs*
	Elementary	*Secondary*	*College*	*Adult*	
Biology			1		1
Chemistry			2		2
Computers				3	3
Electronics			1	1	1
English	2	2	1		3
General Science		1			1
Industrial Arts		1			1
Latin			1		1
Logic	1	1	4	1	4
Mathematics	5	7	8	3	19
Music	1	1	4	1	4
Physics		3		3	4
Psychology			6	1	7
Religion			1		1
Russian		1	2	1	2
Spanish		1	1	1	1
Spelling	1	3	3	2	4
Statistics			3	2	3
Total	10	21	38	19	62

*Some programs are listed at more than one level.

Special Formats: These, in general, are minor variations designed to save space, to present certain auxiliary material in a step, or to permit somewhat greater flexibility in responding. The preceding example is from a program by Gillespie on the fundamentals of music.[4]

A *tie* is also used to lengthen the tone length of a note, but it has a more general property than a dot which we learned lengthened a note by _____(a)_____ its original value. A tie sustains the value of the first note the length of the second. For example, write the three following equations using only one note, i.e., use only one note to complete the equation.

Answers: (a) one *half* or ½

(a) (c) (d)

Vanishing (also called Fading): This perhaps should not be called a variation, since it is very commonly used in constructed-response programs. In general, vanishing is a technique whereby stimulus support for responses is gradually removed in successive steps. It may be done at a fairly abstract or fairly concrete level. It may be regarded as a version of the general principle of gradual progression. Here is an illustration of vanishing at a concrete level: the first item concerned with spelling a particular word, say, *metamorphosis*, might provide most of the word in the

[4] *Some Fundamentals of Music*, Department of Psychology, University of Pittsburgh, 1958, p. 5, step 33. See Part II for further examples and information about this program.

response element, requiring only that certain letters be filled in: met__mor__ hosi__. In subsequent items, stimulus support would be less apparent: me__ __mo__ __hos__ __; and in the final item, it would disappear entirely: __ __ __ __ __ __ __ __ __ __ __ __ __ __ __.

There are many subtle variations on this basic theme, the possibilities evidently depending only on the programmer's ingenuity.

Prompting and Cueing: These are commonly used in program steps. Programmers evidently define the word *prompt* in different ways. To some, it means providing the exact answer required by an item, either somewhere in the stimulus element or filled into the blank the student ordinarily would use. To others, prompting means almost any hint or partial answer that will help the subject respond. For the purposes of this report, prompting means providing the exact form of the response expected of the student. This favors the meaning of the term as used in paired-associate learning (Cook and Kendler, 1956; Cook and Spitzer, 1960).

Prompting, then, means "giving away the right answer." When the prompt occurs in the stimulus element of a step, the student may still be required to respond with the same answer in the response element of the step. This is prompting with *overt* responding. Or the student may be told merely to think of the answer when he comes to the response blank. This is prompting with *covert* responding. The prompt can also be given in the response element in the blank that the student would ordinarily fill in, and the student can be required merely to read the step without writing an answer at all. This is called prompting with *implicit* responding.

Cueing, in this report, means giving subtle hints as to the correct answer, without giving the whole answer away. Almost every step in a program contains cues of one sort or another as to the desired response. There are many possibilities for cueing, again depending on the programmer's ingenuity. He should, however, guard against cues that are irrelevant to the critical information in the step. The relative importance of different types of cueing, as a question to be explored by research is, at present, secondary to the question of prompting versus confirmation. (Confirmation is the "standard" procedure of not giving away the answer to a step, but instead requiring the student to respond, and *then* providing the answer as knowledge of results.)

Branching: Only very few of the constructed-response programs are of this type. Most are linear. In a branching program, not all students take the same sequence of steps. Some branching criterion, such as error rate, is set up by the programmer and branch points are established. Students who meet the criterion at these points subsequently follow one route; those who fail to meet it follow another. Branching programs are more difficult to write, and their superiority has not yet been fully established. Some of the considerations involved, and the research being done, are discussed in a later section of the report.

The Multiple-Choice Program

The characteristics of multiple-choice programs (including intrinsic programs) are summarized in Table 2. Subject matter and educational levels are comparable to categories in Table 1. The intrinsic programs have been described on page 9. (See samples in Part II.)

TABLE 2—SUMMARY OF MULTIPLE-CHOICE PROGRAMS*

Subject Matter	*Level of Instruction***				*Total No. of Programs*
	Elementary	*Secondary*	*College*	*Adult*	
Auto-Instruction			1		1
Bridge				1	1
Chemistry		1	3	3	3
Computers				1	1
Electronics				2	2
Genetics			1		1
Logic				1	1
Mathematics	3	1	1	1	4
Physics	1				1
Psychology			2		2
Russian			1		1
Statistics			1		1
Total	4	2	10	9	19

*Includes Intrinsic Programs.

**Some programs are listed at more than one level.

There are relatively minor differences in the structure of a program step. For instance, a rather elaborate example of a matching type of multiple-choice item is found in the following elementary arithmetic program by Edgar Smith:

Problem	*Process Used*	*Computation*	*Solution*
If you have a dollar, and spend 65 cents for a movie ticket and 10 cents for a "coke," how much will you have left?	add then subtract	$2\overline{)15}$	10¢
How much would three dime "cokes" cost?	add	$2\overline{)20}$	30¢
If you and a friend share a 20-cent bag of popcorn, how much should each pay?	multiply	65¢ 10¢	65¢
How much does a 30-cent hamburger and a dime "coke" cost?	subtract	30¢ 10¢	25¢
If pencils cost two for 15 cents, how much does one cost?	divide	$1.00 .35	8¢
If you have a dollar and spend 35 cents, how much change should you get?	divide and round	10¢ 3	40¢

On the other hand, Sidney L. Pressey of Ohio State University used the following arrangement in his Russian language program:

1. XXXX (Russian word)	a) Cow	b) Horse	YYYYY (Different Russian word)

(Note: The student attempts to match the first Russian word with either choice *a* or *b*. A punchboard gives him knowledge of results, and he knows that the last Russian word matches the other choice.)

Practical Considerations for Programmers

THE LARGE NUMBER of teaching-machine programs in existence suggests that there must be, by now, some experienced programmers. Unfortunately, with a few exceptions, they have not taken the time to summarize their recommendations for the novice. Where, then, can the beginner look for guidance? How can the interested bystander acquire some feeling for what is involved? This section of the report provides a summary of this information, insofar as it is available. Unless otherwise noted, the recommendations apply to writing constructed-response programs.

HOW DO YOU WRITE A PROGRAM?

The program writer needs unusual perseverance, a large amount of time, access to fairly large numbers of students upon whom to test his creations, and a thorough familiarity with the subject matter involved. Assuming that these conditions are present, the procedure from then on becomes somewhat hazy in detail, but clear enough in general.

Programming is not just a process of breaking a textbook organization down into finer detail. Programmers create programs whose organization most likely does not resemble that of any existing textbook. This organization is determined in part by the programmer's notions about what it should be, in part by the fundamental principles which define programmed learning, and in part by the initial reactions of students whose responses are used to refine the program. Therefore, the would-be programmer should read what literature he can find that is descriptive of the process, examine some existing programs, and only then embark upon his own venture. He is quite likely to write the first version of his program with steps that are inappropriate, too difficult, and too few for the material. He may violate the rule that steps must be so easy that the students seldom, if ever, make mistakes in answering them (quite different from item writing for a test).

There is also a real danger that the

programmer will so construct his first steps that the responses to them can be made correctly even though the critical information in the stimulus element was not observed carefully. If so, the student may respond correctly and still not learn. Holland (1960a) cited this problem as one refutation of the claim that "anything put into a teaching-machine program is better than nonteaching-machine material."

Programming, then, is a tedious process of composing steps, trying them out, and rewriting them. Testing usually involves two stages: having a few students and associates react to the raw steps, and having a fairly large number of students work through the complete initial program. At this phase, the programmer is learning from the students.

Very soon in the process the beginner is apt to feel the need for stimulus support in the form of guiding rules and recommendations. It is of little assistance to him to say that programming is an art, which it undoubtedly is. Here, described briefly, are some recommendations and procedures which different programmers have developed. Anyone interested in adopting a particular author's technique should refer to the source articles for more detailed discussions.

Holland's Recommendations

The statements that Holland (1959a, 1959b, 1960b, 1961 in press) has made about programming represent the views of Holland and Skinner (1958), and therefore describe the "classical" programmed learning technique. For him, the important principles which define programmed learning are as follows:

1. There must be immediate reinforcement for each response. This is, of course, one determinant of the basic order of stimulus-response-feedback elements in the step.

2. Only behavior that is emitted and reinforced is learned. A current controversy over overt versus covert responding and prompting versus confirmation has implications for this rule. See research by Cook and Kendler (1956); Goldbeck, Campbell, and Llewellyn (1960); and Holland (1960a).

3. Errors have aversive effects which lower the rate of responding. The difficulty level of steps should be quite low; hence, error rate should be low—on the order of 5 to 10 percent. There is a pitfall in writing easy steps. Unless he is careful, the programmer may provide irrelevant cues which allow the step to be answered correctly even though the student skipped over the important information.

4. There must be a gradual progression from simple to complex concepts in successive steps. This principle of gradual progression applies to the complexity of the abstractions or concepts involved, to the behavior repertoire to be produced in the student, and to the amount of stimulus support given in successive steps.

5. There should be a gradual withdrawal of stimulus support in successive steps (called fading or vanishing). According to this rule, the student must be very slowly "weaned" away from the rich stimulus support given in early steps so that he may be brought to the terminal behavior required of him when he attempts to utilize what he has learned in a performance situation.

6. The student's observing behavior should be controlled. Controlling the stu-

dent's observing behavior while he is working through the program is accomplished in part by using a machine presentation which permits him to move ahead only as he finishes a step; in part by writing the stimulus element so that responding correctly depends on reading it correctly; and in part by writing steps in an interesting and esthetic style.

7. Extensive discrimination training must be given to establish an abstraction or concept. This requires that many examples of the abstraction be given, varying the irrelevant information in the examples so that the student will learn to discriminate the abstraction or concept over a wide range of possibilities.

8. Let the student write the program. Steps are not ready to use for programmed learning until they have been tested on students and revised. This means an adequate sample for establishing difficulty levels of steps and for generalizing to the intended population. Revision involves identification of items that are ambiguous or too difficult, location of gaps in the program, and finding points where it moves too rapidly. In sum, this eighth rule means that several revisions may be necessary before a program is considered satisfactory.

The RULEG System
(Evans, Glaser, and Homme 1960)

This is a formalized procedure for generating program steps. It follows, in the main, the recommendations listed above. The first question for the programmer is whether he thinks it worthwhile to learn this system. If he does, he will have to spend some time learning to use it before he can produce programs, and the results are apt to be different, in subtle ways, than if he had not bothered with it. Since this is a detailed, systematic procedure for programming verbal materials, it does provide stimulus support for the beginning programmer. Its authors are working toward developing a technology of programming which will be generally useful for verbal material.

This system is somewhat difficult to describe briefly. (See Lumsdaine and Glaser, 1960, for more detailed discussion.) It is "based on the premise that the verbal subject material which appears in a program can be classified into two classes of statements which we will call RU's (for *rules*) and EG's (for *examples*)." In this system, program steps can be generated by following these rules:

1. Specify the criterion behavior. This refers to a statement of the objectives of the programmed course. What is the terminal behavior to be like?

2. Write down as many RU's as possible. The authors recommend this step before consulting a textbook to avoid falling under the control of its organization.

3. Collect all the stimulus support you can in the form of texts, notes, advice, etc. This is then converted to RU's and EG's and put on index cards.

4. Make some preliminary ordering of RU's. This is in keeping with the principle of gradual progression, and serves as an initial structuring exercise for the programmer.

5. Make an RU matrix. This is a typical arrangement of rows and columns in which all RU's are to be listed both vertically and horizontally. Each RU is thus related with each other RU by filling in cells. Diagonal cells are used for relating an RU to itself, i.e., for defining

it. It is recommended that several matrices be constructed, one for every different interrelationship that is to be developed among the RU's. Each matrix should be labeled with the name of the particular interrelationship involved. This label is called an operator. For example, there can be relator operators (in what ways are RU's similar to each other?) and discriminator operators (in what ways are RU's different from each other?)

6. Use an example operator in an RU matrix to generate examples for the program. In this matrix, cells are filled with examples which illustrate the RU's. The authors recommend generating an adequate number and "spectrum" of EG's, since this will be necessary for the discrimination learning of the RU's.

7. Number the cells of the original RU matrix to find the order in which the RU's are to be presented. It is recommended that the diagonal cells be used first in order to present definitions of concepts early in the program.

8. Assemble the RU's and EG's into frames. The authors specify in some detail how this is to be done. Generally speaking, they follow the principle of gradual progression, particularly in the gradual removal of stimulus support to produce the desired terminal behavior. Steps would be assembled for all the different locations on gradual progression continua. They recommend that the starting frame-type be of this structure: RU + EG + $\widetilde{\text{EG}}$ (the tilde sign over EG means an incomplete example). This frame-type explicity states the rule (RU), gives the student a completely worked out example (EG), and then gives an incomplete example ($\widetilde{\text{EG}}$) which he must complete.

9. Assemble the frames of various types into a program, using the numbered RU matrix for a guide. The preliminary program is assembled, with steps arranged according to the principle of gradual progression.

10. Try the program out on students and "item-analyze" the responses. In this phase, the programmer should check to see that the desired terminal behavior is being produced. If not, he must add more frames, reduce ambiguities, or rearrange step sequences.

11. Revise the program, using both responses and comments of students. The authors caution against committing too much time and money to reproducing initial programs lest there be a reluctance to break into the format for revisions. They also note that making steps easier in revision is not useful unless they eventually produce the desired criterion behavior, and that supplemental instructions, e.g., "read each frame carefully," should not be used. Finally, as does Holland, they emphasize the danger of writing steps to which the student can respond correctly without observing the critical information.

12. Repeat the tryout and revision procedures until the criterion behavior is produced reliably and efficiently by the program.

Other Comments

Comments of other individuals who have described the process of programming are more or less in agreement with the general pattern which emerges from the above recommendations. Klaus (1961) has suggested seven rules which are briefly summarized below:

1. List the objectives
2. Outline the subject matter
3. Write the draft frames
4. Edit the draft frames (Editing

should be done (a) by another programmer, (b) by a technical expert, and (c) by a skilled writer.)

5. Try out the frames on students (small group)
6. Revise the frames, based on tryout group responses and criterion tests
7. Have a technical expert make a final review of the program.

Gilbert (1958) has a system for classifying items into one of ten different categories based on the function which the item plays in the total program. He found in analyzing one of his own programs that the overwhelming majority of items used were of the restated-review type. He used no rote-review items and only a few delayed-review items. The eleventh classification he presents really cuts across the other ten, since it simply classifies the items according to subject matter. His categories are as follows:

1. Lead-in items do not require new information, nor do they require rehearsal of old skills. Their function is simply to orient the student to a problem and prepare him for new information.

2. Augmenting items supply new information but do not require the student to make a relevant response. If a response is required, it is designed to insure that the student has read an item.

3. Interlocking items require a student to review established skills while new information is being presented.

4. Rote-review items present a problem identical to one presented earlier. They are not especially recommended, except in cases where the memorization of brief verbal material is desired.

5. Restated-review items require a rehearsal of the skill where a problem is restated. Review items are common in most teaching-machine programs, especially in the one that Gilbert helped to design at the University of Georgia for teaching algebra.

6. Delayed-review items allow for the distribution of practice; they differ from other items only in time of presentation.

7. Fading items require the student to review what has been presented; in addition, they withdraw information successively. (They are probably very similar to those used in Skinner's "vanishing technique.")

8. Generalizing items present a verbal statement pointing to a common characteristic of several specific problems already presented to the student.

9. Specifying items exemplify a general rule or principle.

10. Dove-tailing items require the student to make separate responses to separate stimuli that might otherwise become confused.

11. Subject-matter items. Each item should be further classified with respect to its subject-matter content, a type of classification which would cut across the above regular classifications.

Developing Intrinsic Programs

Crowder (1959, 1960) describes his intrinsic programming technique in general terms. Since he views the teaching of human beings as essentially a communication process, he does not restrict his frames to as rigid a model as used in the above techniques. He may employ straight exposition, a leading question, a formal definition followed by examples, a series of examples ending in a definition, an analogy, or any other specific communication technique. The test question in the frame provides several alternatives, each representing a branch point. The programmer presumably selects

these alternatives to illustrate common errors.

Amsel (1960) describes the role of errors in the acquisition of skills and knowledge and illustrates basic conditions from which such criteria might be developed. (In this instance he is not however discussing intrinsic programming.)

In addition to deciding upon the alternatives for the test questions, the programmer using the Crowder technique must devise suitable branches for each alternative in the questions. If a student selects a wrong alternative, presumably the communication failed, and the subsequent branch should attempt to correct the error.

Crowder (1960) describes a number of branching patterns that can be used. A common one explains in a few sentences to the student why his choice is wrong and sends him back to the test question. When he picks the correct answer, he is given simple knowledge of results and sent on to the next frame. More complex branching is possible but is likely to entail difficult program writing and result in prohibitive bulk unless put on microfilm or other compact storage media.

Intrinsic programming does not obviate the need for program revision. It is known that Crowder follows tryout and revision procedures similar to those described above, and that he revises steps when they prove to be too difficult, ambiguous, or inappropriate. The general principle of gradual progression applies to his type of programming as well as to the others.

TIME REQUIREMENTS

There is no really meaningful answer to the question of how long it takes to write a program. Programs are evolutionary instruments, constantly undergoing revision. Programmers evidently do not keep records of time spent on any one revision, and some do not feel that the question is even answerable. When informally asked to give time estimates, several refused to commit themselves.

Yet, some time information would be useful. There should be some way to convey the magnitude of the task, and administrators and managers at least may have a real interest in time data. Table 3 shows that some of the programmers did reply, but the results are presented as gross estimates.

There is fair agreement that on the average a programmer can write about two items per hour of the constructed-response type. This figure is for "finished" items—items that have been revised and are suitable for research or publication.

These results are in agreement with the findings of Klaus and Lumsdaine (1960), who stated:

> We then estimated the time required to write a single frame, based on a survey of a number of programmers: Glaser, Evans, Homme, Holland, Eigen, and ourselves. From their replies, we estimate a typical production rate of only one to two frames per hour. This figure, of course, includes not only writing time, but also researching the subject matter, editing, and trying out of the materials with preliminary subjects.

Several programmers who were asked to give time estimates replied with comments which not only illustrate the difficulty of specifying time, but also provide interesting insights into the mechanics of programming. Some excerpts from these personal communications are presented below:

John Barlow, of Earlham College, commented as follows:

TABLE 3—ROUGH ESTIMATES OF MAN-DAYS TO WRITE PROGRAM STEPS

Respondent	*Type of Steps*[a]	*Estimated Total Steps Written*	*Rough Steps per Man-Day*	*Finished Steps per Man-Day*
1	CR	1,000,000	—[b]	—[b]
2	CR	23,000	40	16
3	CR	20,000	8-20	2
4	CR	15,000	24	16
5	CR	6000	8-24	8
6	CR	4000	30	16
7	CR	500	25	17
8	CR	500	50	15
9	CR	—[b]	64	—[b]
10	CR & other	3800	20-40	16
11	MC	1500	20	8
12	MC	1000	40	10

[a]CR=constructed-response; MC=multiple-choice.
[b]Could not estimate.

The amount of time it takes to write rough items depend on how thoroughly I am involved in the subject matter. For instance, I have been writing some papers on free will and determinism over the past 18 months. One night it occurred to me that I could make a very nice program on freedom and determinism. The first draft of about 28 items took me about three hours to complete in rough form. Now, should I count this as three hours (roughly the time required to actually formulate these) or something in the neighborhood of 100 hours (the rough estimate of the amount of time I have spent reading, thinking, and making other formulations of this material)?

In response to your third question, it depends on your criteria for "suitable for publication or research use." In my own case, as soon as I have written rough items, I test them on subjects. Does this mean that I take zero time to produce "finished items?" On the other hand, I have revised the first lesson I ever wrote about 25 times. At present, I am fairly satisfied with it; but I have not exposed the latest revision to contamination by subjects as yet. Just when are items finished? The lesson I refer to was published in a paper discussing conversational programming after about the fourteenth revision.

In answer to your fourth question, many of the programs at Earlham College do not involve specific items of a question-answer sort. Our programming in language, for instance, involves the Ebacher interlinear method and the use of tape recorders, a type of flash card, and many other auto-instructional devices and procedures which simply cannot be broken down and measured in terms of items.

The remarks below are from H. O. Holt, of Bell Telephone Laboratories:

1. In our *Basic Electricity* program there are about five different types of items: (a) A learning unit (LU) is an item which presents information, usually some new fact, concept, definition, or relationship. (b) A learning cluster (LC) is a review item which integrates material from a portion of the program. (c) A direct recall question asks for a response about some information previously given. (d) An integrating question asks the learner to integrate two or more concepts, definitions, or relationships from previous parts of the program and to respond to this resulting combination. (e) An implicational question asks the learner to respond to some new concept or relationship based on implications or previous material in the program.

2. On the question of time to produce rough items, with the assumption that the

program is outlined and sequenced for all subgoals, then rough items of types (a), (b), and (c) in paragraph 1 were constructed at a rate of about 200 items per man-week. Items (d) and (e) required more time and were constructed at a rate of about 100 items per man-week.

3. Finished items were written in about three stages: (1) After the set of rough items was completed, the items were revised or edited both for ambiguity and content. This revision was done at a rate of about 200 items per man-week, for all types. (2) The complete set of items was then tried out on a few students and, based on these trials, another revision was made again at a rate of about 200 items per man-week. (3) Finally, a full pilot class was run, in which the program was checked completely for errors, ambiguous items, and weak areas. Then, a complete revision was made, using results of the pilot class. This revision was comprehensive, and each item was considered carefully. This might be called the producing of finished items. These items were produced at a rate of about 100 items per man-week for items of types (a), (b), and (c), but only about 50 items per man-week of types (d) and (e). Since the *Basic Electricity* program was about two thirds of the former type, the average rate for producing finished items was about 80 items per man-week.

John Blyth, of Hamilton College, wrote the following:

Here is a description of a typical process in developing and revising a single programmed lesson. Professor X and I are working together in programming a course in Logic. Since we are both thoroughly familiar with the content, there is no need for research. Our first step is a joint discussion to identify the specific concepts or skills to be covered in a set of lessons. We also decide upon the sequence in which they should be presented. We next discuss a variety of approaches, then divide up the work of drafting actual programmed items. The time spent in this kind of discussion and analysis varies considerably. However, I doubt if it comes to an average of more than an hour for one lesson of 40 items.

We have reached the point where we can frequently draft 40 items in their first form in about an hour and a half.

Our next step is to criticize each other's work. We usually spot a number of items, perhaps averaging five, which need some revision. I estimate that this criticism and revision average two man-hours per lesson of 40 items.

The next step is usually to administer the lesson to a class. We then use student assistance to collect the information from eight to 100 answer sheets. The answer sheets we have been using makes this an easy task. The collected information is then used to make an item analysis and introduces any necessary revision. The other morning, for example, it took us about three hours working together to revise two lessons of 40 items. Frequently, a lesson will undergo two such revisions.

The average time we spend writing and revising a single item has decreased sharply in the last two years. This is partly due to experience, of course, but it is also due to a change in the type of items we write. We are concentrating in writing items which are very simple and clear. This change is reflected in the accuracy with which students handle the items. They now go through the lesson at three or four times the earlier rate.

LENGTH OF PROGRAMS

There are some important practical considerations related to the total number of steps in a program. Sheer bulk can have discouraging effects on students. It obviously is expensive to write programs. Present procedures tend to produce steps which are some sort of lowest common denominator for the population involved. Is there any way to improve their efficiency?

At least some students will find that programs containing hundreds or thousands of steps start to pall on them before they finish. Yet, the accepted practice of "letting the student write the program" tends to result in more, not fewer, steps after each revision. It is proposed that two problems related to the total number of steps in a program are worth some discussion.

1. *Step Density per Concept.* Just how many steps are necessary to produce

satisfactory discrimination learning of a concept? And, what is satisfactory discrimination learning? Should a measure of each learning be based on some criterion test score administered immediately after training? How does the programmer know that he has covered all of the important examples of a concept or abstraction? Or, how does he know that he has provided enough practice to insure retention over an appreciable time?

Today the problem of developing an adequate program is approached by successive approximations which produce an approximate solution. This is necessary fundamentally because we do not know enough about human learning to be able to write satisfactory steps beforehand. The results necessarily are applicable only to a population similar to the tryout sample, and then there is a real question as to whether the step density per concept is optimal for each student.

It may be that concept-centered research can provide better guidelines for determining this density. The high cost of program writing clearly requires optimum step efficiency in order that the necessary amount of discrimination training, review, practice, and drill can be more definitely specified and controlled.

2. *Pall Effect.* Can items be too easy? Can steps be so "small" that the brighter individuals in the population become bored with the small increments achieved on each item and thus lose motivation? The writers suggest that as the novelty wears off, the "pall effect" is likely to become a more serious problem than it is now.

The relationship between pall effect and difficulty level may be *U*-shaped rather than linear. Certainly, an extreme case can be postulated in which there are so many easy steps that aversive effects accumulate as the subject works through the program, just as they may accumulate when the subject finds the steps too hard.

Pall effect, its consequences, and the means for avoiding it seem to need further study. There has been a great deal of emphasis on the positive reinforcement that presumably keeps response rates high while students are going through programs. But the reinforcing effects of knowledge of results are partly under the control of the students; items which "insult their intelligence," monotonous sequences of steps written in a mechanical style, and lack of intermediate stopping points in long programs can hardly be positively reinforcing. There is nothing magical about programmed learning that would let the programmer ignore basic considerations of student motivation and the need to stimulate interest in what is being taught.

PLACE IN THE CURRICULUM

The majority of programs developed to date are concerned with elementary or introductory subjects. Consequently, integration with other parts of the curriculum could be a greater problem for more advanced material. Also, many of these programs were written for experimental purposes and not intended for widespread use. Probably, a majority of programs are used as supplements to other instruction rather than as complete teaching methods.

A teaching-machine program is more tightly integrated than is a conventional text. Passages or chapters in the latter may be skipped, the order of topics changed, and so on, to adapt the text to

the requirements of the situation. The organization of programs is less flexible.

If programmed learning becomes widely used in education and training, programmers will need to become more sensitive to meeting the specific and sometimes subtle requirements of the context in which their product is to be used. The specific objectives of training as contrasted with those of education are even more demanding in this regard.

Since it is clear that people can learn by many different methods, programmed learning must compete favorably with other methods, in terms of "educational system" considerations. Will it decrease or increase the need for expensive personnel? Will machines be necessary, and if so, will they be reliable? Can they be serviced by present school personnel? How often do they have to be recharged with fresh programs? Where will they be stored? Will each subject require a book the size of a telephone directory? Are there prospects that present-day versions of programmed learning will reduce the teacher's burden? Or will it be increased for some time? These are questions that deserve careful thought, because they are the ones most likely to be asked by the school or training administrator.

WHAT IS A GOOD PROGRAM?

In the initial scramble to produce marketable programs and machines, there is great pressure to relax quality-control standards for both. Hastily produced programs and defective machines unfortunately are not hard to find. These already have adverse repercussions. Disregarding the problem of machine reliability, what can be done about program quality? The programmer needs some quality guides during production. The interested educator needs criteria by which to select programs. How can these needs be satisfied?

At present, there are no formal criteria. Judgments must be made on common-sense grounds. The programmer should first try out his program to get student reaction, then administer criterion tests. Criterion tests would seem to be the most objective measures of quality, except that typically they are restricted in what they can measure and usually altogether overlook practical issues about which an administrator needs information.

At present, administrators are likely to be besieged by individuals whose talents for the hard sell are antithetical to objectivity. Since a teaching-machine program is at first a radically different organization of material than the administrator is used to, he has little background for making valid judgments of quality or usefulness.

In this regard, programs are apt to resemble tests more than texts. It might be instructive for programmers to contemplate the history of the mental test movement and the quality-control problems still common in the testing field today. What would be analogous to reliability and validity coefficients or descriptions of population norms for programs? Will some latter-day Buros appear to perform the service of collecting standards and critiques? What should be measured that will serve the needs of the field? A useful classification system might contain adequate descriptions of content, intended educational context, and standardization data (on what population was it tested, what were the results, which measures of retention were used, what did comparisons with other methods reveal, etc.).

Holland (1961 in press) suggests criteria which are, essentially, the principles stated in an earlier part of this report. He also suggests that program publishers supply criterion data. He indicates that programs written by subject-matter experts who are already well known are apt to be better risks than those produced by enthusiasts whose knowledge of the technical areas is limited.

Preliminary Classification of Major Programming Variables

THIS SECTION contemplates the broader context of variables that are at least implicit considerations for any educational or learning research activity. Research workers become so accustomed to burrowing through these to the one, two, or three variables that interest them, and programmers are so preoccupied with constructing steps according to formula, that it may be beneficial to call this broader context to the attention of both groups. The intention is to remind the reader that literally hundreds of different factors could be identified that are, or might be, important to the educational task in general, and to programmed learning in particular.

No doubt many of these conditions could be eliminated as matters which are outside the frame of reference of any particular method or experiment. A judicious selection of conditions must be made by any individual investigator so that he can answer questions which he thinks important, or which suit his particular purposes.

These are good reasons for not attempting a general classification of programming variables at this time, Yet, the great complexity of the real world is one of the important reasons that so little of what has been done in the learning theorist's laboratory has been useful to the educator. Teaching machines may yet prove to be the exception. But they are, after all, only one method of many, and they cannot be expected to do all things for all men.

At the present stage of development, they do not venture very far from a formula which has been found to produce results because there has not been time to develop a broader foundation of information.

It can be anticipated that research now underway and to be undertaken will systematically explore more of the variables in programmed learning, and will develop information leading to greater certainty and less speculation about variations in the approach and its applications. It is to be hoped that before this occurs, teaching machines will not be oversold as panaceas for all educational problems.

Research workers in the field of training and education have occasionally attempted classifications of relevant variables and have found them useful. An extremely valuable taxonomy of educa-

tional objectives has been developed to help those who deal with curriculum and educational measurement problems (Bloom, 1956).

Although the Outline of Programming Factors presented in this section represents many hours of work, it is incomplete. It would profit from contributions by individuals representing differing points of view in psychology and education. Hopefully, it is a beginning toward a classification scheme that can be used for: (1) comparing programs and research studies using programs, and (2) suggesting areas needing further investigation.

Undoubtedly, in the next few years educational administrators and officers in charge of training facilities will be deluged by salesmen selling both devices and programs. Certain sections of the classification presented here might be very useful as a check list, or as a source of questions to present to the salesman. (See Part IV in the Outline.)

Those faced with the problem of writing programs will have to make some decisions from among such categories as programming techniques (II-C), subject matter organization (III-B), and media for presenting steps (II-I). It may be helpful to have a range of choices spelled out for them.

Teaching-machine literature abounds with some rather foggy terms, such as "step size" or "step difficulty." Some of the sub-categories referred to in Part I of the Outline (e.g., number of different ideas, vocabulary load, cueing, and type of response required) may help to specify more exactly just what is meant by a small or a large step.

A glance at the teaching-machine literature will show much work in certain areas (e.g., prompting versus confirmation) but little research on other variables. Perhaps this classification will help to direct research into these relatively unexplored areas.

Since the preceding section of this report discussed many of the terms used in programming, no attempt will be made to describe the Outline section by section. There are, however, occasional examples or words of explanation.

OUTLINE OF PROGRAMMING FACTORS

I. Factors Relating Primarily to an Individual Step

A. Symbols used to communicate information in the step
   1. Words
   2. Pictures
      a. still
      b. movie
   3. Graphs, diagrams, etc.
   4. Numbers, mathematical and logical symbols

B. Basic dimensions of the step
   1. Stimulus element
      a. number of symbols (words, pictures, etc.)

b. number of different ideas
c. approximate reading time
d. readability (vocabulary load, sentence length, person, style, etc.)

2. Mediating activity between stimulus and response element
   a. type (e.g., recall, recognition, complex processes)
   b. accessibility to observation or control
      (1) no evidence of mediation
      (2) observable mediating acts
      (3) planned mediating acts (suggested by program)

3. Response element
   a. number of symbols required
   b. level of ideational content (e.g., handwriting, low; spelling, medium; problem solving, high)
   c. approximate response time
   d. response mode
      (1) no response required
      (2) covert response
      (3) overt response
   e. type of response
      (1) written (words-symbols)
      (2) motor skill
      (3) vocal
      (4) bioelectrical (e.g., GSR, EEG)

4. Feedback element (knowledge of results)
   a. type
      (1) simple right-wrong indicator
      (2) correct answer (confirmation)
      (3) explanation of why right or wrong
   b. relation to response element
      (1) response must occur first (machine-controlled)
      (2) response need not occur first (book format)

C. Programming techniques used with step

1. Cueing (hinting at correct answer in stimulus element)
   a. incomplete answer given
   b. semantic cue (e.g., "Cold air goes down, but hot air goes ____.")
   c. mechanical cues (underlining, color, etc.)
   d. synonyms (for the answer)

2. Prompting (giving away the whole answer)
   a. located in stimulus element
   b. located in response element
      (1) replaces response
      (2) response also required

D. Relation of step to program

1. Serial order (first, middle, last section, etc.)

2. Interdependence with other items
   a. continuous discourse
   b. independent items

E. Statistical characteristics of step

1. Probability of correct response
2. Other item analysis data

II. Factors Relating Primarily to Sequences of Steps or the Entire Program

A. Basic program dimensions
   1. Number of steps
      a. per lesson or similar sub-unit
      b. in whole program
   2. Approximate time to complete
      a. one lesson or similar sub-unit
      b. whole program
   3. Physical space occupied
      a. in storage
      b. in use

B. Coordinate or supplementary presentations
   1. Visual displays
      a. written verbal material
      b. pictures
         (1) still
         (2) motion
      c. other graphic material
   2. Audio presentation
      a. verbal
      b. music
      c. other signals
   3. Other instructional techniques (intermixture with programmed learning)
      a. laboratory
      b. instructor(s)
      c. discussion groups
      d. textual references
      e. classroom lecture

C. Programming techniques used
   1. Vanishing (gradual removal of stimulus support)
   2. Conversational chaining (correct answer located in the next stimulus element)
   3. Intrinsic programming (see pages 18-19)
   4. RULEG (see pages 16-17)
   5. Branching
   6. Miscellaneous

D. Type of step sequences
   1. Linear
   2. Branching
      a. patterns
         (1) simple wash-back (repeat branching items)
         (2) complex wash-back (repeat segment of program)
         (3) wash-ahead (skip one or more steps)
         (4) sub-programs (remedial loops-parallel track)

b. control
(1) by student (voluntary)
(2) by instructor
(3) by program (intrinsic program)
(4) by device (criteria could be: error, error-rate, latency, group performance, etc.)

E. Repetition and practice
1. Amount
2. Scheduling
3. Timing
a. immediate
b. delayed
4. Criteria (practice to mastery, overlearning, etc.)

F. Discrimination and generalization
1. No discrimination or generalization (learn one response to another stimulus)
S — R
2. Stimulus generalization (several stimulus patterns elicit one response)

3. Response generalization (one stimulus pattern elicits several responses)

4. Stimulus discrimination (pick out which of several stimulus patterns for response)

5. Response discrimination (learn which of several responses for a stimulus pattern)

6. Generalized stimulus to generalized response (several stimulus patterns elicit several responses)

G. Reward and reinforcement (applicable both to one step and to more than one step)
1. No reward and no knowledge of results
2. None other than knowledge of results
3. Additional reward
a. type
(1) primary
(2) secondary
(3) negative
b. control and scheduling

(1) amount per unit (fixed or variable)
(2) frequency per unit (fixed or variable)
(3) timing (immediate or delayed, fixed or variable)
(4) relation to response
(a) indiscriminate (occurs whether R is right or wrong)
(b) discriminating (only right answers rewarded)

H. Quality control data
1. Quality of subject matter in program
a. reputation of author
b. rating of objective criteria
c. rating by experts
2. Quality of programming
a. evidence from tryout and revision
b. conformity to accepted programming principles
c. conformity to general standards for graphic material
3. Pall effect (the tendency for aversive effects to accumulate as a student works through a program)
a. appropriateness of material for the student
b. presence of subgoals in long programs
c. esthetic quality of format and style
d. length of work period or learning session
e. total length of program

I. Sensory modalities and media for presenting steps
1. Visual media
a. paper and pencil
b. projectors and similar machines
c. three dimensional objects
2. Auditory media (e.g., tape recorders)
3. Tactual, kinesthetic, and olfactory media

J. Rate of presenting steps
1. Scheduling and control
a. variable, under student's control
b. variable or fixed, under control of device
2. Criteria for control of rate
a. error, error rate
b. latency of responses
c. predetermined

III. Factors Relating Primarily to Subject Matter and Student Characteristics

A. Types of subject matter
1. Scientific
2. Social science
3. Language
4. Mathematics
5. Mechanical
6. Artistic
7. Psychomotor

B. Subject-matter organization
   1. Chronological (historical)
   2. Natural unit
   3. Problem-centered
   4. Sequential steps
   5. Theoretical
   6. Practical
   7. Analytic (whole to parts)
   8. Synthetic (parts to whole)
   9. Direction of effort (e.g., English to Spanish, Spanish to English)

C. Individual differences
   1. Aptitude for learning (intelligence and aptitude tests)
   2. Personality factors
   3. Biological and physical factors
   4. Social factors (previous experience, social values and goals, etc.)
   5. Self-instructional sets (e.g., intention to learn)

IV. Factors Relating Primarily to Criteria of Learning Efficiency

A. Measurement of results of learning
   1. When measured
      a. during learning (integrated in program or special acquisition tests)
      b. after learning
         (1) immediate retention
         (2) delayed retention
   2. What measured
      a. rote memory for facts
      b. generalization of concepts
      c. transfer to performance context
   3. How measured
      a. recall
      b. recognition
      c. re-learning
      d. performance
   4. Type of measure
      a. program step
      b. achievement test
      c. performance test
      d. job sample test
      e. observation or rating on job
      f. attitude scale or inventory
   5. Type of quantification
      a. R-W counts or other objective scoring
      b. subjective ratings
      c. derived indicators (acquisition or retention curves, etc.)

B. Assessment of training efficiency
   1. Cost per unit
      a. per program

   b. per student
   c. per machine
2. Investment
   a. initial
   b. long term
3. Training time per student
4. Quality of students required (aptitude, experience, etc.)
5. Quality of instructors required (credentials, experience, etc.)
6. Logistics involved
   a. space, power, maintenance requirements
   b. program re-usability, useful life
7. Practical effectiveness of method
   a. in relation to training objectives
   b. in relation to competing methods
8. Acceptance of method
   a. by students
   b. by instructors
   c. by administrators

C. General educational objectives (see Bloom, 1956)
1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation

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27. Pressey, Sidney L. "A Machine for Automatic Teaching of Drill Material." *School and Society* 25: 549-52; 1927.

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31. Silverman, R. E. *Automated Teaching: A Review of Theory and Research*. Technical Report NAVTRADEVCEN 507-2. Port Washington, New York: U.S. Naval Training Devices Center; June 1960.

32. Silverman, R. E. *The Use of Context Cues in Teaching Machines*. Technical Report NAVTRADEVCEN 507-1. Port Washington, New York: U.S. Naval Training Devices Center; March 1960.

33. Skinner, B. F. "The Science of Learning and the Art of Teaching." *Harvard Educational Review* 24: 86-97; Spring 1954.

34. Skinner, B. F. "Teaching Machines." *Science* 128: 969-77; October 24, 1958.

35. Stolurow, L. M. *Teaching by Machine*. Urbana: University of Illinois; September 1960.

PART II

Program Samples

Part II is intended to show a variety of programming samples, including both subject matter and programming styles. Since programming is still somewhat of a nebulous art, many of these programs must be considered "experimental" rather than finished models. The authors offer this collection of samples in an attempt to stimulate the flow of information in this rapidly growing field.

The Department of Audiovisual Instruction has published a list of commercially available programs and devices in its April issue of *Audiovisual Instruction*, extra copies of which are on sale from the Department for 50 cents.

The samples in this section are arranged in alphabetical order; by general subject matter, author's name, and titles of specific programs. Program samples are coded on the upper right corner of the page according to type and educational level. The code used is as follows:

E = elementary

S = secondary

C = college or university

A = adult (self-education, military training, industrial training, etc.)

CRP = constructed-response program

MCP = multiple-choice program

SBP = scrambled-book program (intrinsic program)

Thus, (A) MCP refers to a multiple-choice program intended for adult education.

Boxes, lines, and other graphic arrangements appearing in the original frames have not in every case been reproduced in the samples. In general, almost any of the programs could be presented in a variety of formats.

■ AUTO-INSTRUCTION

Pressey, Sidney L. (C) MCP

Chemo Card. Columbus: Ohio State University. Available only to qualified researchers. Length, 1 page.

(Strictly speaking, this material is not part of a "program" but simply a brief auto-instruction for use of the "chemo card." This 3x5 card has two columns of 15 lines each of four quarter-inch squares, or answer-boxes for 30 four-choice questions. The "correct" box in each of the 30 lines has been treated with an invisible chemical. The student uses a fountain pen filled with a special pink ink which instantly turns gray if a mark is made in the chemically treated box.)

The "chemo card" is a simple device which tells you at once, as you answer questions like number 1 in the next paragraph, whether the answer you have chosen is right or wrong! Four possible answers are given, labelled (a), (b), (c), and (d). You are to indicate which answer you think is right by making a cross with your pen in square "a," "b," "c," or "d," in the row numbered "1," on the card. Answer "b" is right. So make a good heavy cross in square "b" in the first row of squares on the chemo card. Do it!

1. What should you do, if you think answer "b" is right for this first question? (a) underline it, (b) make a cross in square "b" in the first row of squares on the card, (c) write "b" before that question, (d) write "2."

   At once, little grey dots showed through the pink marks in square "b"; these indicated that you marked the right answer. However, if you mark a wrong answer the mark remains clear. Mark square "a" in the first row. The mark remains clear. This shows your answer "a" is wrong. But when the dots showed in square "b," that told your answer "b" was right. Now go on to question 2.

2. What happens if you mark a wrong answer? (a) your mark turns green, (b) dots show, (c) the mark disappears, (d) it remains clear. Answer "d" is correct—so mark square "d" in row "2." Dots show in the mark. Then mark square "a," "b," and "c" in row "2." These marks remain a clear pink or light red, thus showing that answers "a," "b," "c" are wrong.

   Now go on, and mark your answers to the remaining questions on this page. If you mark a wrong answer, *try another until you find the right answer to each question.* The card thus finds each right answer for you.

3. If a clear pink mark shows that you do not have the right answer, you should (a) carefully re-read the question, then mark the square in that same row corresponding to the answer you now think right, (b) go to the next question, (c) guess, (d) stop work.

4. You know at once when you find the right answer because (a) a buzzer sounds, (b) the mark doesn't show, (c) the instructor tells you, (d) gray dots show faintly on the mark.

5. Once you find the right answer you should (a) hurry to the next question, (b) consider why it is right and remember it, (c) forget it, (d) write it down.

6. If you don't know the answer to a question, you should (a) skip it, (b) mark the answer you think most likely, (c) guess, (d) swear.

7. Be very careful not to lose your place and (for example) mark a square in row "8" when considering question 7, because (a) it's against the rules, (b) it's cheating, (c) you'll injure the card, (d) your mark will turn gray only for the answer to question "8" which may be wrong for question 7.
8. You should (a) work as fast as you can, (b) go very slowly with great care, (c) work steadily without hurry, (d) rest frequently.

■ BIOLOGY

Stephenson, William K. (C) Continuous Discourse CRP

Comparative Animal Physiology Self-Instruction Review Material: Cell Program. Richmond, Indiana: Earlham College. Project coordinator, John A. Barlow. Copyright 1961, William K. Stephenson. Available only to qualified researchers. Length, 103 items on cell physiology (several programs all small and topical).

19. Vacuoles are fluid filled structures within the _____ of the cell.

    cytoplasm

20. Vacuoles are filled with _____.

    fluid, liquid

21. Fluid filled structures in the cytoplasm of a cell are termed _____.

    vacuoles

22. Chloroplasts are a type of plastid in the cytoplasm of plant cells which function in the process of _____.

    photosynthesis

23. Plastids are large (usually greater than 2 microns) regularly shaped structures in the _____ of plant cells.

    cytoplasm

24. Chloroplasts are a type of large regularly shaped structures called _____.

    plastids

25. A type of plastids found in plant cells?

    chloroplastids (chloroplasts)

26. A fluid filled structure in the cytoplasm?

    vacuole

27. Mitochondria are small round or thread-like bodies (usually 1-3 microns long) in the _____ of cells.

    cytoplasm

28. Mitochondria contain enzymes which are important in the release of energy by respiration. Does respiration take place in the nucleus or cytoplasm?

    cytoplasm

29. Cytoplasmic structures containing enzymes active in respiration?

    mitochondria

■ BRIDGE

Crowder, Norman A. (S, C, A) SBP

Bidding in Contract Bridge. Santa Barbara, California: Western Design & Electronics, Division of U.S. Industries, Inc. Copyright 1960, Norman A. Crowder. Copies of this program are not available; but "The Elements of Bridge" by Charles H. Goren is available from Doubleday and Co. at $3.95. Length, 21 pages for sample; 420 for Goren program.

Tutortext Page 1

This is an automatic tutoring book on bidding in contract bridge. *It is different from any other book you have ever used*. The pages are numbered consecutively, for reasons that will become apparent. At the bottom of each page you will find directions telling you which page to turn to next. You will find that using this book is like having an expert bridge player watching over your shoulder, pointing out, explaining, and correcting your errors, and complimenting you on a correct bid.

The bidding is conducted according to the point count system. Aces in hand count four points; Kings three points; Queens two points; and Jacks one point. A doubleton (that is, only two cards of one particular suit in the hand) counts one point, a singleton two points, and a void in any suit three points. It is considered advisable to hold 14 points in your hand before opening in a suit; 16 to 18 for a No-Trump opener, and more than 23 points before opening with a two bid.

The Blackwood Convention is used in this book. This means that when four No-Trump (4 NT) is bid, it is a request for information of the number of Aces held by the partner; an answer of five clubs means no Aces; five diamonds one Ace; five hearts two Aces; five spades three Aces. A bid of 5 NT similarly is a request for the number of Kings held by the partner. Now go on to Page 11 for the first hand.

* * *

Tutortext Page 2

You did not follow the instructions. In this type of book you do not turn directly from Page 1 to Page 2. As you finish each page of material you will find directions telling you where to turn to find the next page *you* should read. The reason for this is that different people will read this book in different ways. There is no place in this book that directs you to this page, Page 2! You should turn back to Page 1, therefore, and read the instructions again.

* * *

Tutortext Page 11

HAND #1

You are South, and you will open the bidding. You hold this hand:

SPADES 6 HEARTS AKJ976 DIAMONDS KQJ6 CLUBS A4

What is your opening bid? Select the bid you think best and turn to the page whose number is given after the bid you think best.

1 Diamond	Page 13	1 No Trump	Page 14
1 Heart	Page 7	2 Hearts	Page 16

* * *

Tutortext Page 13

SPADES 6 HEARTS AKJ976 DIAMONDS KQJ6 CLUBS A4

Your opening bid: 1 Diamond. In addition to the rules, or laws, of bridge, bidding in bridge is governed by certain agreements or conventions, which enable your partner to gain information about your hand from the bids you make. One important convention is that you always open with your longest suit. In this hand, your hearts are both longer and stronger than the diamonds. Therefore, if you open with 1 diamond your partner would be misinformed about your hand. Misinforming your partner leads to disaster and sometimes bloodshed. Now return to Page 11 and pick a better bid.

* * *

Tutortext Page 7

Your opening bid: 1 Heart. You are correct. This is a good, 21-point hand with length in a major suit—hearts. The AKJ of hearts adds up to 8 points, the KQJ of diamonds is 6 points, the A of clubs is 4 points, the doubleton (the two clubs) is 1 point and the singleton (the one spade) 2 points. The hand is not strong enough for an opening two bid, which requires 23 points, but if your partner is able to cooperate you may go places. All right, your opening bid is 1 heart. The bidding proceeds: (your hand is shown below)

SPADES 6 HEARTS AKJ976 DIAMONDS KQJ6 CLUBS A4

South	*West*	*North*	*East*
1 Heart	Pass	3 Hearts	Pass

Your partner has responded with three hearts. What is your best bid now?

4 Hearts	Page 4	5 Hearts	Page 15
4 Diamonds	Page 12	6 Hearts	Page 8
4 No-Trump	Page 3		

* * *

Tutortext Page 14

SPADES 6 HEARTS AKJ976 DIAMONDS KQJ6 CLUBS A4

Your opening bid: 1 No-Trump. Remember that your bid serves to tell your partner what kind of a hand you have. With a bid of one No-Trump you would be telling your partner that you had about the same number of cards in each suit, that is, something like a 4-3-3-3 distribution. This is not the case at all. The distribution in your hand is 1 spade, 6 hearts, 4 diamonds, and 2 clubs. With such a 1-6-4-2 distribution, your opening bid should tell your partner about your long suit in hearts, particularly as you have high cards in that suit. With 21 points in your hand (2 Aces are 8, 2 Kings are 6, 1 Queen is 2, 2 Jacks are 2, the doubleton in clubs is 1, and the singleton in spades is 2) your opening bid should tell your partner how strong your hand is and what your long suit is.

Now return to Page 11 and pick a better bid.

■ CHEMISTRY

Belfort, Alan M., and Belfort, Anne D. (S, C, A) MCP

Review of High School Chemistry. Bala Cynwyd, Pennsylvania: General Atronics Corporation, copyright 1961. Programmed text using both write-in and multiple-choice responses, available September 1961. Length, 3000 frames.

9. All the atoms of any one particular element are exactly alike, but are unlike the atoms of every other element.
   a. a variety of
   b. different
   c. similar
   d. identical

10. An atom is the smallest part of an element capable of existing alone; therefore, it is the smallest unit of an element which takes part in a chemical change.

    Each atom retains the chemical properties of the _____ of which it is a smaller part.
    a. atom
    b. compound
    c. element
    d. mixture

11. Atomic scientists have discovered that atoms can be broken down into smaller particles of matter. When the *atom* is "split," its principal components are *atomic particles* called electrons, protons, and neutrons.

    Electrons, *protons*, and *neutrons* are _____ that are the principal components which result from the splitting of atoms.
    a. atomic particles
    b. elements
    c. substances
    d. chemical properties

12. An *atom* is infinitesimal in size and is the smallest part of an element capable of existing alone.

    An *atomic particle* is _____ in size than an atom and _____ capable of existing alone.
    a. smaller; is
    b. smaller; is not
    c. greater; is
    d. greater; is not

13. *Unlike* the atom itself, *atomic particles* _____ retain the chemical and physical properties of the elements of which they are a part.
    a. do
    b. do not

Benfey, O. T. (C) CRP

Systematic Naming of Alkanes. Richmond, Indiana: Earlham College. Project coordinator, John A. Barlow. Copyright 1961, Earlham College. Available only to qualified researchers. Length, 24 items.

This program is designed to acquaint the student with the Geneva System of nomenclature of saturated aliphatic hydrocarbons. (For the complete system cf. *Journal of the American Chemical Society* 82: 5545, 1960.)

As you work through each page, cover all except the first question with a sheet of paper, answer the first question on a second sheet of paper and then check it against the answer given in the program directly below the question. Expose question 2, and proceed as before.

1-1 Alkanes are hydrocarbons containing the maximum number of hydrogen atoms possible for a given number of carbon atoms. If the number of carbon atoms in a given alkane is n, then the number of hydrogen atoms is found to be $2n + 2$. Thus when $n = 1$, $2n + 2 = 4$: the simplest hydrocarbon, *methane*, also known as marsh gas, has the formula CH_4. We can write the general formula of alkanes as C_nH_{2n+2}. The formula of the alkane, *ethane*, containing two carbon atoms, is therefore _____, and of the three-carbon alkane, *propane* is _____.

C_2H_6, C_3H_8

1-2 When we reach alkanes with four or more carbon atoms, we find that more than one compound has a given formula. Thus *two* different alkanes exist, both containing *four* carbon atoms. Both have the formula _____.

C_4H_{10}

1-3 But in the one case, the four carbon atoms are in a single continuous chain, C-C-C-C, while in the other only three are in a chain, the fourth being attached to the center of the chain, thus

```
C-C-C.
      |
      C
```

Now carbon has a valence of 4, while hydrogen is monovalent. When we attach hydrogen atoms to all the unused carbon valences, the four-carbon chain formula can be represented as

```
      H H H H
      | | | |
H-C-C-C-C-H
      | | | |
      H H H H
```

This is often called normal butane or *n-butane*. The analogous representation for the branches butane (common called *isobutane*) would look like this: _____

```
    H H H
    | | |
H-C-C-C-H
    |   |
    H   H
        |
      H-C-H
        |
        H
```

Day, Jesse H. (C) SBP

Kinetic Theory of Gases. Athens: Ohio University. Copyright 1958, Jesse H. Day, Pocketschool Series. Available only to qualified researchers. Length, 60 pages.

Scrambled Book Page 1

This book is different from any other book you have read in that the pages are not read consecutively. On each page you will be asked a question. The answer you choose will direct you to the page to which you should turn next.

The Kinetic Theory of Gases. A common form of scientific theory is the "model" theory. The behavior of some general kind of matter (such as gases) is studied. Then a "model" of the substance is drawn or imagined. The best model is the simplest which will behave in the same way as the real substances. If study of the model leads to predictions of behavior not yet actually observed, and these predictions are confirmed by experiment, then the model has served a useful purpose.

If real behavior can be explained and understood by reference to the model, and predictions be made of properties previously unknown, then we feel some confidence that the model bears correspondence to the actual reality.

The Kinetic-Molecular Theory of Gases is a simple model of the gaseous state. It is a highly successful model, based on the observed behavior of real gases. In this chapter we will check the reasonableness of the model, and see what kinds of "predictions" it leads to.

It is assumed that you already understand what a molecule is; that a molecule is the smallest particle of a given kind of matter (as, O_2 is a molecule of oxygen) and that all molecules of a given substance are identical (ignoring isotopes for now).

The object of this book is to discover some things about gases, based on your own ability to reason. Now turn to page 12.

* * *

Scrambled Book Page 2

You did not follow instructions. Nowhere in this book are you directed to this page. In this kind of book you do not read pages consecutively, as you do in ordinary books.

Now go back to Page 1. Continue and try again.

* * *

Scrambled Book Page 12

Careful measurements in many laboratories show that all gases are highly compressible. If a sample of gas is kept at constant temperature, then doubling the pressure on the gas reduces the volume to half of what it was; increasing the pressure ten times cuts the volume to one-tenth, and so on, up to very high pressures.

NOW—what do you think is *really happening* when a gas is compressed?

p. 6 (1) The molecules of the gas are flattened out and made smaller.

p. 16 (2) The molecules are not changed. They are merely shoved closer together.

p. 14 (3) Both (1) and (2) happen.

* * *

Scrambled Book Page 6

Your answer was No. 1: *The molecules of air are flattened out and made smaller.*

When molecules are close together as in any liquid (water, for example) or solid (such as ice), then even tons of pressure can only compress the liquid (or solid) very little, while just doubling the pressure of a gas reduces the volume 50 percent! Water vapor behaves like gas and is highly compressible. How come the liquid water is not compressible? In other words, molecules don't compress!

Turn back to page 12 and select a reasonable answer this time.

* * *

Scrambled Book Page 16

Your answer was No. 2: *The molecules are not changed. They are merely shoved closer together.*

You are correct. You knew that the main difference between a gas and the liquid or solid state of the same material is that the gas can occupy an indefinitely large volume. (For example, 18 g of water or ice fill about 18 cc, but the same amount of water vapor will fill 22,400 cc and still be exerting a pressure for more expansion.)

If the volume increases, without needing any more material, then in going from the liquid (or solid) to the gaseous state can be only the increasing of distance between the molecules. Conversely, the molecules in a liquid or solid must be very close together, and the molecules themselves not compressible, since experience is that even great pressures do not compress a liquid (or solid), to any appreciable extent. Turn to page 17.

* * *

Scrambled Book Page 14

Your answer was No. 3: *Both (1) and (2) happen.*

You are half right and all wrong. Turn to page 6.

Darby, C. L., and Mager, R. F. (C) SBP

Molecular Solutions. Athens: Ohio University. Available only to qualified researchers. Length, 35 pages.

Scrambled Book Page 1

This is an automatic tutoring or "scrambled" book applied to the concept of *molar* solutions. It is different from any other book you have read in that the pages are not read consecutively. On each page, you will be asked a question. The answer you choose will direct you to the page to which you should turn next.

The appendix (page 35) contains all the information you should need to work through the material presented in this book. To begin, turn to page 10.

* * *

Scrambled Book Page 10

Let's begin by reviewing the definitions of solutions, solvents, and solutes. You will recall that a *solution* is a homogeneous molecular mixture of substances. The liquid in which a solid or gas has been dispersed to from a solution is called the *solvent*, and the substance dissolved, the *solute*. In the case of two liquids or two solids, each one may be said to be dissolved in the other, though the one present in larger quantity is usually termed the solvent.

Now let's see how well you remember these definitions.

If you were to mix 500 milliliter (ml) of sulfuric acid with one liter of water, the water would be termed the _____.

p. 3 Solvent
p. 6 Solute
p. 13 Solution

* * *

Scrambled Book Page 3

Your answer was: *solvent*.

Correct. The substance present in a solution in the largest quantity is usually termed the solvent.

There are a variety of ways in which we could describe the quantities of solutes, their weight, volume, etc. One convention is to talk about the gram-molecular weight of substances. This is simply the molecular weight of the substance expressed in grams. For example, the gram-molecular weight of water would be:

p. 15 18.02
p. 8 16.00

* * *

Scrambled Book Page 6

Your answer was: *solute*.

No, the solute is that substance which is dissolved in another substance. This latter substance is called the solvent and is usually the substance present in the largest quantity. Since a liter is equal to 1000 milliliters (ml), we have twice as much water as sulfuric acid.

If we were to dissolve common table salt in water, the water could be called the _____.

p. 3 Solvent
p. 4 Solute

* * *

Scrambled Book Page 13

Your answer was: *solution*.

The term "solution" refers to the molecular mixture of the water and whatever other substance has been dissolved in it. Thus, a solution is the resulting combination of two or more substances.

Now turn to page 10 and try again.

Finelli, Carole, and Sager, Robert W. (C) CRP

Chemistry—Pharmacology. Developed under the direction of Robert Glaser, Department of Psychology, University of Pittsburgh, copyright 1960. Copies of this program are not available. Length, 630 frames.

(There are 12 sections of from 40 to 70 items, each covering a separate vitamin.)

1. *Introduction to Vitamin A*—The first vitamin to be studied derives its *alphabetical designation* from the fact that it was the first substance to be placed in the category of *nutritionally essential factors*. This vitamin is known today as _____ _____.

   Vitamin A

2. Vitamins are called "accessory food factors," and are necessary for normal nutrition and growth. When the needed amount of a vitamin is not present in the body, there is a vitamin _____.

   deficiency

3. Vitamin A was originally recognized as a substance needed in the diet of rats to maintain normal _____.

   growth

4. This dietary growth factor can be supplied to the body not only by substances containing Vitamin A, but by *carotenes*. Carotenes are red and yellow colored pigments found within the cells of plants. Carotenes are associated then in some way with supplying Vitamin _____ to the body.

   A

5. Carotenes, those pigments found in _____, are hydrolyzed or broken down to form Vitamin A. Carotenes are substances occurring *before* the vitamins and are called *precursors*. (*Pre* meaning before).

   plants

6. Carotenes are colored pigments occurring in plant cells. Carotenes will break down to form _____ _____.

   Vitamin A

7. Carotenes are present before Vitamin A is formed. Thus, one can say that carotenes are _____ of Vitamin A.

   precursors

8. A precursor of Vitamin A is a _____.

   carotene

9. Carotene *precursors* are also called *pro-vitamins*. This is another term that means occurring *before* the vitamin. Thus, when talking of vitamins, precursor and _____ are interchangeable terms.

   pro-vitamin

■ COMPUTERS

Crowder, Norman A. **(S, C, A) SBP**

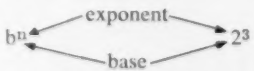
The Arithmetic of Computers. Santa Barbara, California: Western Design & Electronics, Division of U. S. Industries, Inc. Copyright 1958, Norman A. Crowder; 1960, U. S. Industries. Published by Doubleday and Co. Tutortext, $3.95. Length, 480 pages.

Tutortext Page 1

We have defined the symbol b^n as meaning "the product reached by using the number *b* as a factor *n* times." Thus, for example

$$2^3 = 2 \times 2 \times 2 = 8$$
$$3^3 = 3 \times 3 = 9$$
$$b^2 = b \times b$$

We have also learned that in an expression of the form b^n, the number *b* is called the base and the number *n* is called the exponent.



Finally, we have seen that a number expression such as 2^3 is called "the 3rd power of 2" or "2 raised to the 3rd power," and so on. Now, here is a question on this review material. Pick an answer and turn to the page number given after the answer you choose. The question is: If the base of an expression is 2, and the exponent is 3, what is the expression equal to?

Answer	*Page*
8	5
9	9
I have no idea	13

* * *

Tutortext Page 5

Your answer was: *If the base of an expression is 2 and the exponent is 3, then the expression is equal to 8.*

You are correct: $2^3 = 2 \times 2 \times 2 = 8$

Very well. Now, to continue this quick review, you may have learned previously that if b^m and b^n are two powers of the same base, then there is a short-cut way of multiplying these two numbers, as shown below:

$$(b^m)\ (b^n) = b^{(m+n)}$$

Thus $(2^3)\ (2^5) = 2^{(3+5)} = 2^8$

and $(4^2)\ (4^3) = 4^{(2+3)} = 4^5$, etc.

Also, there is a similar rule for division involving two powers of the same base.

$$b^m / b^n = b^{(m-n)}$$

Thus $5^6 / 5^4 = 5^{(6-4)} = 5^2$

and $7^3 / 7^2 = 7^{(3-2)} = 7^1$, etc.

These "formulas" were justified at some length in the full text of *The Arithmetic of Computers*. Here we must merely state them and hurry on to get to the interesting part. But let's be sure you have understood what has been said up to now. What is the result of dividing 8^6 by 8^2?

Answer	*Page*
$8^6 / 8^2 = 8^{(6/2)} = 8^3$	10
$8^6 / 8^2 = 8^{(6-2)} = 8^4$	14
I don't know	18

* * *

Tutortext Page 9

Your answer was: *If the base of an expression is 2 and the exponent is 3, then the expression is equal to 9.*

You have it backwards. You used the number 3 as the base and 2 as the exponent, and we want it the other way around.

In our brief discussion on page 1, we stated that in the expression b^n the number *b* was the base, the number to be used as a factor, and that the number *n* was the *exponent*, which tells the number of times the base is to be used as a factor. So if the base is 2 and the exponent is 3, and we substitute these values in the expression b^n, we have 2^3.

Now, 2^3 means the product reached by using the number 2 as a factor 3 times. And, what is "2 used as a factor 3 times" equal to?

Return to page 1 and choose the correct answer.

* * *

Tutortext Page 13

Your answer was: *I have no idea.*

Well, let's see if we can explain it a little more fully.

Some of the numbers in our number system are the products of factors. The number 15, for example, is the product of the numbers 5 and 3. That is, $5 \times 3 = 15$. The numbers 5 and 3 are called "factors" of 15.

Now, there are some numbers that are the product of the *same* factor used a certain number of times. The number 16, for instance, is the product of the number 4 used as a factor twice $4 \times 4 = 16$. A number that is the product of the same factor used a certain number of times can be written in the form b^n, where *b* is called the *base* and represents the number that is used as a factor and *n* is called the *exponent* and tells the number of times the base is to be used as a factor. So the number 16 written in the form b^n would be 4^2, and 4^2 means "4 used as a factor twice," or $4^2 = 4 \times 4 = 16$.

Hughes, J. L., and Baker, J. J. (A) CRP

IBM 83 Sorter. New York: Applied Personnel Research, IBM, copyright 1960. Available only to qualified researchers. Length, 352 frames.

1. Sorting is the arranging or classifying of punched cards into a numerical or alphabetical sequence. To prepare accounting reports it is usually necessary that the cards be _____ or arranged in a desired sequence.

   sorted

2. Arranging punched cards in sequence or _____ by hand is slow and subject to error. One type of IBM machine, called a _____, can arrange cards in sequence with great speed and accuracy.

   sorting (classifying) *Sorter*

3. Several types of Sorters are available with speeds ranging from 650 to 2000 cards per minute (cpm). The 82 Sorter operates at the lower of these speeds, or ≠_____ cpm, while the 84 Sorter operates at the higher of these speeds, or ≠_____ cpm.

   650 (cpm) *2000 (cpm)*

4. Different types of Sorters have speeds ranging from ≠_____ cpm to ≠_____ cpm. The 83 Sorter, which you are studying now, has a speed of 1000 cpm. Because the 83 Sorter has a speed of only ≠_____ cpm, it is not the fastest Sorter available.

   650 *2000* *1000*

5. The 83 Sorter can arrange in sequence or _____ cards at the rate of ≠_____ cpm.

   sort *1000*

Hughes, J. L., and O'Neal, H. R. (A) CRP

Introduction and Programming for 7070 Data Processing System. New York: Applied Personnel Research, IBM, copyright 1960. Available only to qualified researchers. Length, 719 frames.

1. The 7070 is a data processing system. To prepare a payroll, to maintain an inventory, or to perform other accounting applications, a customer can use the 7070 data _____ _____.

processing system

2. All data processing systems require some type of input unit or units. In order to put information into the 7070 _____ _____ _____, an _____ unit is required.

data processing system *input*

3. In addition to one or more input units, all data processing systems require some sort of processing unit or units to operate on the input data. The 7070 has several _____ units to process input data.

processing

4. Data are put into the 7070 by means of an _____ unit. The information is then operated upon by several _____ _____.

input *processing units*

5. All data processing systems must also have output units to write out information in a usable form. A mechanical printer is an example of an _____ unit.

output

* * *

32. The unit record input and output units operate at a much slower speed than the processing units. To allow the processing units to process at high speed while the unit records units read in or write out information, a temporary storage is required. In the 7070, information is temporarily stored on the _____ _____.

magnetic drum

33. A magnetic drum storage device stores information as magnetized spots on the surface of a rotating cylinder. In the 7070, one of these is located in the 7600 I/O Control unit. A _____ _____ storage device is located in the _____ /_ _____

magnetic drum *7600 I/O Control*

34. Information read into the system by the _____ Card Reader unit passes through the 7603 I/O Sync unit and is stored on the _____ _____ in the 7600 __/__ _____ unit.

7500 *magnetic drum* *I/O Control*

35. Data being transferred from the processing units of the 7070 to the _____ Printer or _____ Card Punch are temporarily stored on the _____ _____ located in the _____ I/O Control unit.

7400 *7550* *magnetic drum* *7600*

Hughes, J. L., and Yochmann, H. (A) CRP

Introduction and Programming for SAGE Computer. New York: Applied Personnel Research, IBM, copyright 1960. Available only to qualified researchers. Length, 860 frames.

1. The word "computer" comes from the Latin verb "computare," which means to calculate. Thus, a computer is a device that calculates. According to our definition, any device that calculates may be called a _____.

computer

2. The adding machines used in business offices could also be called _____ since they are used for calculating.

   computers

3. The device called the "Abacus," which was built by the Chinese to do calculating could also be called a _____ as we have defined the terms.

   computer

* * *

43. We can summarize by saying that in a data word, the _____ of a number is represented by the 15 bits following the sign bit. A sign bit of "0" indicates a _____ number while a sign bit of "1" indicates a _____ number.

    magnitude *positive* *negative*

44. So much for the data word. Now let's look at the other type of computer word, the instruction word. Previously, we have said that the computer is told what to do through the use of _____ words. The contents of these words will determine what operation is performed.

    instruction

45. The actual instructions appear coded in binary number form in the left half-word of the _____ word. The coded number consists of different configurations of bits which appear in the _____ half-word of the _____ word.

    instruction *left* *instruction*

46. The computer knows what operation is to be performed by decoding the configurations of bits which appear in the _____ half-word of the _____ word.

    left *instruction*

47. For the computer to perform an addition, the instruction "ADD" would have to appear coded as a binary number in the _____ half-word of the _____ word.

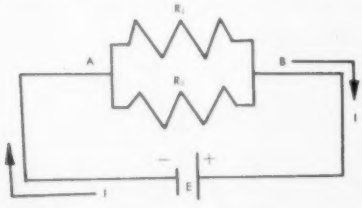
    left *instruction*

■ ELECTRONICS

Hughes, Robert J., and Pipe, Peter (A) MCP

Introduction to Electronics. Santa Barbara, California: Western Design & Electronics, Division of U. S. Industries, Inc., copyright 1961. Published by Doubleday and Co. Tutortext, $3.95. Length, 421 pages.

Tutortext Page 83



Your answer: *The voltage drop across R_1 is the same as the voltage drop across R_2.*

Right! Since the voltage drop across R_1 is equal to the difference in electrical pressure between Point A and Point B, and the voltage drop across R_2 is also equal to the difference in electrical pressure between Point A and Point B, the voltage drop across the two resistors is equal. Now we know that in a series circuit, the total resistance is the sum of the individual resistances. Or $R_{total} = R_1 + R_2 + R_3 \ldots$ (The dots here mean "and so on.")

What happens to the total resistance in a parallel circuit? The answer is that it is always less than the smallest single resistance. This is not surprising if you put together the things you already know. Double the cross-sectional area of a conductor, and you halve the resistance. Remember? If R_1 has a value of 10 ohms, and R_2 also has a value of 10 ohms, your total resistance is only 5 ohms. But what if R_1 has a value of 12 ohms, and R_2 has a value of 6 ohms. Then what is your total resistance?

8 ohms	Page 90
Less than 6 ohms	Page 94

* * *

Tutortext Page 90

Your answer: *8 ohms*

No! You were advised that the total resistance in a parallel circuit is always less than the smallest single resistance. In the circuit described in the question, R_2 had a value of only 6 ohms. Why, then, would the combined resistance climb up to 8 ohms?

Please return to page 83 and select the correct answer.

* * *

Tutortext Page 94

Your answer: *Less than 6 ohms*

Right! And we will now develop the formula for how *much* less. Let's say that $E_{ab} = 24$ volts, $R_1 = 12$ ohms, and $R_2 = 6$ ohms. We know by now that $I_1 = E/R_1 = 2$ amps. And we know that $I_2 = E/R_2 = 4$ amps. So total current in the circuit is 6 amps. It's easy enough to calculate total resistance now. If $E = 24$ volts and $I = 6$ amps, $R_{total} = E/I = 4$ ohms, which indeed is less than R_2.

Luxton, Dean H., and Corrigan, Robert E. (A, C) CRP

How to Read a Resistor. Basic Skill Films, 1355 Inverness Drive, Pasadena, California. Copyright 1960. Published as a 35mm silent color filmstrip, $6.75. Length, 62 frames.

Frame 1. This is a resistor. It is used in electronic circuits to resist or oppose the flow of electrical current.

Frame 2. The electrical value of a resistor is measured in OHMS. The larger the amount of resistance, the larger the number of _____.

Frame 3. The electrical value of a resistor is measured in OHMS. The larger the amount of resistance, the larger the number of *OHMS*.

Frame 4. The electrical value of this resistor in ohms is shown by the colors painted in bands around its body. You will learn this color code.

Frame 5. To learn to read the electrical value of a resistor, you must learn to read the _____ bands.

Frame 6. To learn to read the electrical value of a resistor, you must learn to read the *color* bands.

Frame 7. In this system, each color represents a different number.

Frame 8. In this system, therefore, colors represent _____.

Frame 9. In this system, therefore, colors represent *numbers*.

Frame 10. In this lesson you will learn to read only five color-number combinations. Study them carefully:

Black =	B	= 0	Orange = Or = 3
Brown =	Br	= 1	Yellow = Y = 4
Red =	R	= 2	

Frame 11. Black (B) means zero, nothing, 0. In this code, when you see B think of "nothing" and write the number _____.

Frame 12. Black (B) means zero, nothing, 0. In this code, when you see B thing of "nothing" and write the number 0.

Frame 13. Brown (Br) = 1. When you see Br think of the number 1. Therefore:

Black = B = _____. Brown = Br = _____.

Frame 14. Brown (Br) = 1. When you see Br think of the number 1. Therefore:

Black = B = 0. Brown = Br = 1.

Schuster, Donald H. (A, C) SBP

Trouble Shooting Strategy. Los Angeles: Electronics Personnel Research Group. University of Southern California. Copyright 1960, Donald H. Schuster. Published by the Institute of International Research and Development, Inc., Box 4456, Lubbock, Texas. Programmed text, $7.50. Length, 200 pages.

Page 48

Your answer was: *"Trouble Shooting."*

You are correct. Getting specific experience with each piece of equipment is one way of becoming a good trouble shooter—for that piece of equipment. But learning how to use sound trouble shooting *principles* helps you to become a better trouble shooter, possibly to become an expert.

These trouble shooting principles came from years of practical experience and many research studies. The principles are not startling, new, or different. They emphasize checking efficiency, practicality, and maximal use of information. Systematic application of these principles will lead the trouble shooter to success with a reasonable number of checks.

There are two questions to answer at each step or check in the trouble shooting process: (1) *where* to check, and (2) *what* type of check to make. The trouble shooting principles help you answer these questions.

Question: How many trouble shooting principles are there?

Page 23. You don't know
Page 79. Two

* * *

Page 23

Your answer was that you didn't know.

You are correct, and let me compliment you. You have sharp eyes. The question actually asked how many principles there are, not how many questions one should ask. We have not yet discussed how many trouble shooting principles there are, but we will proceed to discuss them now.

In trouble shooting, the first question that has to be covered is, "*Where* should you check?" This can be answered by a logical sequence of general steps which fall into two major sequences:

I. *Initial bracketing:* You first determine the broad limits within which the defects or difficulties must be located; this is called the area of uncertainty.

II. Then, you keep *narrowing down the limits* so that the area of uncertainty becomes smaller until the specific defects are pinpointed.

Initial Bracketing

Establishing the broad limits or brackets of the area of uncertainty is generally accomplished by the following sequence of three steps:

(1) *Symptom-pattern recognition:* Find the symptoms indicating malfunctioning.

This involves front panel checking to find all the symptoms. Look at the indicators on the front panel or panels for the system. These may be oscilloscopes, meters, speakers, etc. Identify all the symptoms of trouble that appear on these indicators. Do you have signals, auditory signals, grass? Are the sweeps on the scope normal?

After you have determined what the symptoms are, what do you think the next step should be?

Page 37. Check the indicator (scope, speaker or meter) that has the symptoms.
Page 86. Make sure all the tubes are lit.
Page 54. Look up the over-all block diagram of the system.

* * *

Page 79

Your answer was: "*Two.*"

In trouble shooting, you are going to have to learn to use your eyes, think correctly,

and pay attention to significant details. Did the question ask for the number of principles or the number of basic questions? Return to page 48 and try again.

■ ENGLISH

Blumenthal, Joseph C. (S) CRP

English 2600: A Scientific Program in Grammar and Usage. New York: Harcourt, Brace & World, Inc., copyright 1960. Paperbound, $2.60. Length, 2632 frames (448 pages.)

Each page of the workbook is divided into six panels (or "frames"), printed in alternate bands of white and light gray. On page 3, the top panel or "frame" of the six on this page looks like this:

	Here is a *complete sentence* of only two words: *Birds fly*. We know what this sentence is about. It is not about *dogs* or *horses*. It is about _____.

The student fills in the blank and turns to page 5. Here is what he finds in the top panel on that page:

birds	*Birds . . .* *Birds fly* is a sentence, but the word *birds* by itself is not a _____.

If, however, by any chance he has put "flying" instead of "birds" in the space provided on page 3, he turns back immediately to that page to try to reason out why he was wrong. If he still doesn't understand, he asks the teacher who might point out to him that, in this particular example, "birds" is to "dogs" and "horses" as "fly" is to "run" and "gallop," or anything else that might occur to him to help this very slow student over the first hurdle.

Back on page 5 once more, the student writes his answer to the second question in the space provided and then turns at once to page 7, where he finds this:

sentence	The word *birds* by itself merely *names* a topic that we might talk about. To make a sentence of it, we must *tell* something about _____.

The answer to this question, "birds," appears in the box at the left of the top panel or frame on page 9, and this is followed by the next (fourth) question, the answer to which appears at the top of page 11.

The student begins the course by going through the book, taking only the top gray frame on each right-hand page (pages 3, 5, 7, 9, 11, etc.). When he reaches the end of the book (page 439), he turns again to page 1 and follows the second band—a white one—through the book, still working on the odd-numbered (right-hand) pages. He continues in this way through the third, fourth, fifth, and sixth bands, beginning on page 1 and following the appropriate panel through to the end of the book. When he comes to the last white band on the last right-hand page (Frame 1320), he turns back to page 2 and starts reading the gray panels at the top of the left-hand pages, continuing through the book by following each horizontal band through the left-hand (or even-numbered) pages.

Meyer, Susan R. (S, E) CRP

Vocabulary. Cambridge: Psychological Laboratories, Harvard University. Copyright 1960, Susan R. Meyer. To be published by Harcourt, Brace, & World, Inc. in 1962. Research form, 1160 frames; publication form, 2000 frames.

1. A prefix is a piece of a word that comes before a root. A suffix is a piece that comes after a root. Every word that has more than one piece must have a _____.

   root

2. The root of the word restless is _____. The root of the word unrest is _____.

   rest

3. A suffix is a piece that comes _____ the root in a word. A prefix is a piece that comes _____ the root.

   after, before or in front of

4. The word restless has a root, *rest*, and a _____, *less*. The word unrest has a root, *rest*, and a _____, *un*.

   suffix, prefix

5. A word can have two suffixes. Every piece that comes after the root is a _____.

   suffix

6. The word restlessness has _____ parts; *less* is a _____, and *ness* is a _____.

   two, suffix, suffix

7. In the word restlessness there are two suffixes. The suffixes *ness* and *less* are separate pieces. Each one has a meaning of its own. Each one adds to the _____ of the whole word *restlessness*.

   meaning

8. The suffix *ness* makes a noun when it is added to an adjective like *red*. We can talk of a "red sweater" or we can talk of the "red _ _ _ _ of a sweater."

   red n e s s

9. If you like a friend's sweater, you can say: "I like that red sweater." If you want to say that you like the color rather than the style, you would say: "I like the red _ _ _ _ of that sweater."

   red n e s s

10. If you say: "I like the blueness of the sky," are you saying that you especially like the color blue, or are you saying that you especially like the sky? Which? _____.

    the color blue

McCarthy, O. Neil, and Della-Piana, Gabriel (E, C) CRP

Vocabulary Building. Salt Lake City: University of Utah, 1951. Copies of this program are not available. Length, 12 lessons, 9 to 30 frames per lesson (334 frames).

1. New words are often acquired in our language and in other languages by putting old _____ together to form new meanings.

   words

2. Parts of many words may be seen to have a _____ of their own apart from the meaning of the whole word.

   meaning

3. Many words therefore may be broken up and defined in terms of the separate _____ of each part of the word.

   meaning

4. The basic or simplest part of a _____ is the *root*.

   word

5. Other parts of the word that come before or after the basic part or _____ fill out and expand the meaning.

   root

6. A *prefix* is the part of the word that comes before the _____.

   root

7. You probably know that a preview is shown _____ an advertised picture comes to a movie house.

   before

8. A *preview* is a view that comes "_____."

   before

9. A prefix then must come _____ the *root* in a word.

   before

10. The part of the word prefix that means "before" is _____.

    pre

11. *Fix* in the word *prefix* is the _____ and means "to attach." *Pre* in the word *prefix* is the _____ and means "before."

    root *prefix*

12. The whole word *prefix* means to "_____ _____."

    attach *before*

■ GENERAL SCIENCE

Glaser, Robert; Schaefer, Halmuth H.; Jeffries, Arthur; Phillips, Howard; and Harakas, Theodore (S) CRP

Work and Machines. Department of Psychology, University of Pittsburgh, copyright 1961. Copies of this program are not available. Length, 1150 frames.

35. We can use this example of the wall to illustrate the difference between *energy* and *work*. In order to do work, you use *energy* to cause something to _____.

    move

36. You use *energy* on the wall but the wall does not *move*. You get tired because you are using *energy* on the wall, but since the wall is not _____, no work is being done.

    moving

37. You can show this to yourself. When you push against a brick wall for a long time, you get tired. You are not doing *work*, but you are using up _____.

energy

38. You probably have always thought that doing a *job* is the same thing as doing *work*. Pushing against the wall may be doing a *job*, but it is not doing _____ since the wall is not moving.

work

39. When you are talking to your friends, you might say, "Pushing against this wall is hard work!" But in the language of science, you are not doing work since the wall is not _____.

moving or moved

40. But when you push against a desk and slide it across the floor, the energy which you use to move the desk across the floor results in _____ being done.

work

41. *Energy* is the ability to do _____. But that *energy* must *move* something in order for _____ to be done.

work *work*

■ GENETICS

Burmester, M. A., and Lawson, C. A. (C) SBP

Theory. East Lansing: Michigan State University. To be copyrighted by Michigan State University. Available only to qualified researchers. Length, one term's work.

(This program contains three sections of about 25 pages each. A sample page is reproduced below. Each section has about two pages of introductory text and diagrams. The authors have developed the space saving device of having several scrambled items per page and labeling the page sections 3a, 3b, 3c, etc.)

Page 3A

You are correct. Where in the series of development stages of the child must the "thing" be at first?

1. Gamete	Page 4A	3. Fetus	Page 5B
2. Zygote	Page 7A	4. Embryo	Page 8C

* * *

Page 3B

Your answer is incomplete. The answer you give is a sex cell produced by one sex. What is the general term for sex cell? Go back to page 4B.

* * *

Page 3C

You have answered this correctly. The next problem is to postulate the "thing" that is carried or transported from generation to generation. The zygote and early stages

of development of an individual do not have albinism; we may therefore assume that albinism itself is not transmitted, but that something is transmitted that causes albinism to develop later. We cannot see this something, but we can assume that it is present but very small. Because this imagined "something" is useful in explaining how traits can be transmitted we name it. It has been called a gene. Environmental effects do not cause albinism; the zygote does not show the characteristic which appears eventually. Assume that characteristics do not arise without cause. On the basis of the above facts and assumptions, do you infer that there is a gene in the zygote which caused the appearance of the albino characteristic in the developing embryo?

1. Yes Page 9A
2. No Page 4C

* * *

Page 3D

You are way off. A fetus which has all parts of the individual formed is a late stage in the development. Try again. Turn back to page 2.

■ INDUSTRIAL ARTS

Smalley, Lee (S) CRP

Computing the Cost of Wood. Buffalo: New York State University College of Education. Single copies available free from the author. Length, 16 items.

1. We usually use three ways to compute the cost of wood; by the lineal foot, square foot, and board foot. The lineal foot is the simplest, requiring only that you know the length of the board, so that one lineal foot would be ——— inches long.

   12

2. The square foot only takes into account length and width, so that a piece one foot wide and ——— foot long, would be one square foot.

   one

3. A board foot, which is a square foot one inch thick, uses length, times width, times the thickness over one inch. If the material is under one inch thick, then it is considered one inch for computing board feet. A piece one foot square and two inches thick would have ——— board feet in it.

   two

4. There are 144 square inches in a square foot, but this is not necessary to know when buying material by the ——— foot.

   lineal

5. If the measurements are in feet, you multiply L × W, but if they are in inches, you convert square inches into square feet by dividing the total number of square inches in the material by the number of square inches in a square foot, which is ———.

   144

6. After you have figured the amount of material you have, multiply this figure X the cost of the material, so that three board feet at 10 cents a board foot would be ——— ———.

   30 cents

7. A piece of material four feet long, six inches wide, and two inches thick would be _____ lineal feet, _____ square feet, and _____ board feet.

   four *two* *four*

8. Remember lineal feet require only that you know the length of the material and how much it is per lineal foot. One hundred feet of 4x4's would be _____ lineal feet.

   100

9. Two by fours are sold by the lineal foot, so that four pieces of 2x4's twenty feet long at 10 cents per lineal foot would cost _____.

   $8.00

■ LATIN

Hoose, I. K. (C) CRP

Ablative Absolute. Ohio: Kent State University. Copyright 1960, I. K. Hoose. Copies of this program are not available. Length—spelling, over 300 words; grammar and spelling, 50 pages.

Ablative absolute refers to a clause, attendant upon the main clause.

Having made this speech, he dismissed the meeting. (Translate into Latin)

_____

Hac oratione habita, concilium dimisit.

The ablative absolute is grammatically unconnected with the rest of the sentence. In thought, it is an adverbial modifier of the verb.

With you as leader, we do not fear. (Translate into Latin)

_____

Te duce, non timemus.

When Cicero and Antonius were consuls, Catiline formed a conspiracy. (Translate into Latin)

_____

M. Tullio et C. Antonio consulibus, Catalina coniurationem fecit.

The subject of the subordinate clause is in the ablative along with its modifiers.

His friend being wounded, the boy fled from the place. (Translate into Latin)

_____

Suo amico vulnerator, puer ex loca fugit.

* * *

Some verbs are conjugated only in the active but have passive meanings. These verbs are called "*deponent* verbs."

conor (try): conari is the _____; conatus sum is the _____.

infinitive *perfect indicative*

vereor (fear): _____ is the infinitive; _____ _____ is the perfect indicative.

veri *veritus sum*

sequor _____; patior _____; experior _____.

follow *suffer* *try*

■ LOGIC

Allen, Layman E.; Brooks, Robin, B.S.; Dickoff, James W.; and James, Patricia A. (E, S, C, A) CRP

Symbolic Logic. New Haven, Connecticut: ALL Project, Yale Law School. Available only to qualified researchers from the senior author. Incomplete as yet—4 chapters, 1510 frames. Part I, 5 chapters projected; Part II, still undetermined.

S401 We describe system F by specifying

1. the symbols in system F,
2. the WFFs in system F,
3. the LAFs in system F, and
4. the proofs in system F.

We specify first the _____ in system F.

symbols

S402 System F has as its only symbols

1. sentence variables,
2. connectives, and
3. "therefore" indicators.

Thus, every symbol in system F is either

1. a _____ _____, or
2. a _____, or
3. a " ⊢ "

sentence variable *connective*

S403 Every p, q, r, s, and t is a sentence variable in system F. Thus, since every sentence variable in system F is a symbol in system F, every —, —, —, —, and — is a symbol in system F.

p *q* *r* *s* *t* (in any order)

S404 Every K, A, C, and N is a connective in system F. Thus, since every connective in system F is a symbol in system F, every —, —, —, and — is a symbol in system F.

K *A* *C* *N* (in any order)

S405 Thus, every symbol in system F is either

1. a p, a _____, an _____, an _____, or a _____; or
2. a K, an _____, a _____, or an _____; or
3. a " ⊢ "

q *r* *s* *t* (in any order); *A* *C* *N* (in any order)

S406 Copy those of the following which are symbols in system F:

K	i	m	a
⊢	q	s	B

⊢ *K* *q* *s* (in any order)

S407 Notice that given any symbol, we can decide whether or not that symbol is a symbol in system F. Because we can make this decision no matter what symbol we are given, we have effectively specified the _____ in system F.

symbols

Blyth, John W., and Jacobson, John, Jr. (S, C) CRP

Probability Theory and Logic. Clinton, New York: Psychology Department, Hamilton College (under a grant from The Fund for the Advancement of Education). Available only to qualified researchers. Length, approximately 10,000 items.

(The first of the following three lessons is used to introduce problems dealt with in probability theory. The second lesson introduces some concepts in propositional logic. Both lessons illustrate an emphasis on a progression from simple familiar concrete cases to abstract principles. Approximately 8000 items have been prepared for a year course in logic, semantics, and scientific method.)

PROBABILITY

1. All standard pennies tossed on a hard surface will land heads up or _____ up.

   tails

2. Assuming that a standard penny does not stand on edge, roll away, etc., there are _____ ways in which it might land.

   two

3. Of the two possible ways in which a penny may land exactly, _____ is heads up.

   one

4. There is just one out of _____ possibilities that a tossed coin will land tails.

   two

LOGIC

1. [This book is closed]. The statement in brackets is *true* as applied to Book I. It is _____ as applied to II.

   false, or not true

2. p [Book I is open]. q [Book II is open]. Statement p is *false*. Statement q is _____.

   true

3. Both books are closed, but we might have other arrangements as follows:

(2).

(3).

(4). ?

open

Hamilton Research Associates, Inc. (C) Experimental CRP

An Introduction to Permutations. New Hartford, New York: Hamilton Research Associates, Inc. Copyright 1960, John W. Blyth. Booklet form, 75 cents. Length, 20 items.

1. Mary finds five new customers who expect to be waited on in order of their arrival. Mary has one chance in _____ of guessing the correct order. Remember your estimate to compare it with your answer at the end of this short lesson.

   Go directly to the next question

2. Sally and Joe want to use the same telephone. If Sally gets there first, Joe must wait. If Joe gets there first Sally must wait. There are exactly _____ different ways for them to take turns.

   two

3. After Joe gets through, there are _____ ways in which Mary and Sally may take turns.

   two

4. If Sally goes first, Joe and Mary may take turns in _____ different orders.

   two

5. Any one of three may go first. No matter who comes first, there are _____ left for the second turn.

   two

Evans, James L. (C) CRP

Symbolic Logic. Developed under the direction of Robert Glaser and Lloyd E. Homme, University of Pittsburgh. Copyright 1960, James L. Evans. Copies of this program are not available. Length, 130 frames.

S-1. This sign is named "wedge": $\vee$. It is called a connector, since it connects any two letters when it appears between them. For example, we would write "m wedge r" like this: m $\vee$ r. Now you write "k wedge t":

   $k \vee t$

S-2. This sign is named "tent": $\wedge$. It is also used to *connect* two letters when it appears between them. For example, we write "a tent g" like this: a $\wedge$ g. Now you write "h tent p":

   $h \wedge p$

S-3. This sign is named "spear": $\rightarrow$. It is also used as a *connector* between two letters.

For example, we write a "g spear t" like this: g➚t. Now you write: "g spear w":

g➚w

S-4. " ∧ , ∨ , and ➚ " are named _____ since they are used to connect two letters by appearing between them.

connectors

S-5. We are going to learn some rules about letters and connectors. To make things easier to talk about, we will give each step a Step Number. For example: (1) p➚t (2) n ∨ m (3) a ∧ b
Here "a ∧ b" is Step Number 3, "p➚t" is Step Number ___.

3

S-6. You are going to learn a number of rules for dealing with letters connected by "➚," " ∧ ," and " ∨ ." As you use each rule it will be convenient to use the two initial letters to show which rule you have used. For example, the first rule which you will learn will be the Wedge Adding Rule, and the initials are WA. Next, you will learn the Tent Joining Rule, and you might guess that the initials are _____.

TJ

S-116. Here Line Shift and Tent Disconnecting have been used to get to W:
(1) p ∧ o ∧ r / W: p (2) p ∧ o ∧ r LS 1 (3) p TD 2

Now use Line Shift and Tent Disconnecting to get to W:
(1) r ∧ s ∧ t / W: r ∧ s (2) (3)

(2) *r ∧ s ∧ t LS 1* (3) *r ∧ s TD 2*

S-117. Note that *no* steps were given below, so that Wedge Bar was used first to make up Step 1, and then Spear Wedge was applied.
W: $\overline{p}$➚$\overline{p}$ (1) p ∨ $\overline{p}$ WB (2) $\overline{p}$➚$\overline{p}$ SW 1

Now you used Wedge Bar and Spear Wedge to get to W below:
W: $\overline{\overline{a}}$➚$\overline{\overline{a}}$ (1) (2)

(1) *$\overline{a}$➚$\overline{\overline{a}}$ WB* (2) *$\overline{\overline{a}}$➚$\overline{\overline{a}}$ SW 1*

Silberman, Harry F.; Coulson, John E.; Melaragno, Ralph J.; Estavan, Donald P.; and Englund, Donald F. (S) MCP

Symbolic Logic. Santa Monica, California: System Development Corporation. Copies of this program are not available. Length, 400 items.

1. Below is a series of sentences, arranged to form what is called in logic an "argument," in English and in symbology. d ∨ s

Either Sammy Davis dances or he sings. s
Since he sings he must not dance. ∴ ~ d

What would you say about this argument:
(2) I admit it—I just can't understand the whole thing
(3) the argument looks OK to me
(4) the argument looks wrong to me
(5) the English part looks good—but not the symbology

Go on to page 2

2. That argument you just saw is called a *fallacy*. It is not logically correct. In the

teaching session you are about to start, you will learn how to analyze such arguments. You'll learn how to put an argument into symbolic form, and how to determine whether it is logically correct or logically incorrect. When you are ready to begin, turn to page 3 and you're off. Good luck, and enjoy your automated teaching experience.

3. The field of logic deals with statements and relationships among these _____.

   (2) numbers
   (3) statements
   (4) equations

4. Statements are sentences that must be either true or false. Can a question, exclamation, or command be a statement?

   (2) YES
   (3) NO

398. Look at your answer sheet. Did you miss any of the questions on pages 395, 396, and 397?

   YES: turn to page 399
   YES: turn to page 414

399. Let's try another example of denying the antecedent. Symbolize the following invalid argument:

   If this candidate used money to secure his election, he deserved defeat; but he did not use money in this way, and therefore did not deserve defeat.

   (2) $r \rightarrow s$, $\sim r$, $\therefore$ ____ s (3) $r \rightarrow s$, r, $\therefore \sim s$ (If you chose 2—go to page 400) (If you choose 3—go to page 403)

400. Symbolize the circled statement in the following argument:

   If this candidate used money to secure his election, he deserved defeat;

   but he did not use money in this way, and therefore did not deserve defeat.

   (2) $r \rightarrow s$ (3) $r \vee s$ (4) $r \wedge s$

■ MATHEMATICS

Banghart, Frank (E) CRP

Fourth Grade Arithmetic. Charlottesville: University of Virginia. Available in Fall 1961.

In all the problems we have just done, we have known both parts and the sum before we subtracted. We can also subtract without having both parts and the sum.

If we have 4 balls and only 2 of them are white, we know that there are 2 balls that are *not* white.

$4 - 2 =$ _____.

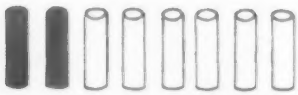
2

If we have 5 balls and only 2 of them are white, we know that there are 3 balls that are *not* white.

$5 - 2 =$ _____.

3

* * *



If we have 8 sticks and only 2 are black, we know that _____ sticks are *not* black.

6

2 sticks subtracted from 8 sticks = 6 sticks
$8 - 2 =$ _____.

6

* * *

Mary made 10 lines on a piece of paper. She made 4 long lines. The other lines were short. Mary made 6 short lines.
$10 - 4 =$ _____.

6

* * *

John had 10 blocks. Six were black and the rest were white. John had _____ white blocks.

4

Calvin, Allen (Project Director) (C) CRP

Intermediate Calculus and *Differential Equations*. Encyclopaedia Britannica Films, Inc., copyright 1960. Programmed textbook *(Intermediate Calculus)* $7; *(Differential Equations)* $7. (Preliminary edition for testing only—383 pages, 1500 items.)

1. Throughout this course we shall be concerned with numbers. Recall that a number is positive if it is greater than (that is, larger than) 0; 5, 6, 10/3, are positive numbers and 2, 17/2, 37 are _____ numbers.

   positive

2. The simplest kind of numbers is the counting numbers or positive integers, such as 1, 2, 3, 4, etc. The numbers 123, 50, 70, 11 are all _____ numbers or _____ integers.

   counting *positive*

3. A number is negative if it is less than (that is, smaller than) 0. The numbers -3, -7, $-31/34$ are all negative numbers, just as -1, -11, $-21/2$ are _____ numbers.

   negative

4. The collection consisting of the counting numbers 5, 50, 21, 14 is a collection of positive _____, while the collection of the numbers -3, -31, -57, -213 is a collection of _____ integers.

   integers *negative*

5. The number 0 is an integer, but it is usually considered as being neither positive nor negative. Numbers greater than 0 are called _____ numbers and numbers less than 0 are called _____ numbers.

   positive *negative*

* * *

501. The reader should *always* be aware of the fact that a (real) function f consists of *three* things: (1) a set D(f) of real numbers, called the _____; (2) a second (not necessarily different) set R(f) of real numbers called the _____; and (3) a rule which assigns to each number in D (f) _____ number in R(f).

   domain of f, *range of f,* *one and only one (or exactly one)*

502. If we say "consider the function $f(x) = \frac{x}{x-4}$," we understand that D(f) = _____ and that R(f) = _____.

   $\{x: x \in E \text{ and } x \neq 4\}$; E

503. If $g(x) = \sqrt{2x-1}$ defines a function g, then we understand that D(g) = _____ and that R(g) = _____.

   $\{x: x \in E \text{ and } x > \frac{1}{2}\}$ or $\{x: \frac{1}{2} \leq x < \infty\}$; E

504. A function consists of _____ things, *always*.

   three

Calvin, Allen (Project Director) (C) CRP

Introduction to College Mathematics. Encyclopaedia Britannica Films, Inc., copyright 1960. Programmed textbook, $7. (Preliminary edition for testing only—502 pages, 1809 items.)

1. The language of elementary algebra consists of certain statements about numbers. 0 and 1 are examples of _____.

   numbers

2. 3 and 7 are also _____.

   numbers

3. ¾ and 7/8 are also considered _____.

numbers

4. −5, −13 and 7/8 are still more _____.

numbers

5. In the language of elementary algebra we use certain strings of symbols called *expressions* to represent numbers. For example, the string of three symbols 1 + 1 is an expression. It represents the number _____.

2

* * *

644. We have proved the theorem which states that if the variable *a* does not represent the number *0*, then $ax = a \Longrightarrow x = 1$. For example, if $5x = 5$, then $x =$ _____.

1

645. The only number which behaves like the number *1* is the number *1* itself. If $8x = 8$, then $x =$ _____.

1

646. Suppose that $ax = a$. If the variable *a* does not represent the number *0*, then the variable *x* in this equation must represent the number _____. However, if the variable *a* does not represent the number *0*, then the variable *x* in this equation can represent _____.

1 any number

647. *Theorem* 5 expresses the *uniqueness of reciprocals*. In other words, Theorem 5 states that $ax = 1 \Longrightarrow x = 1/a$. That is, the only number which when multiplied by *a* gives the product *1* is the _____ of *a*.

reciprocal

648. Since Theorem 5 is a conditional statement, in order to prove it we first temporarily assume the hypothesis: $ax = 1$. We would like to multiply both sides of this equation by the reciprocal of *a* in order to obtain the desired conclusion. However, before we use the reciprocal of any number for any purpose, we first must make certain that the number is not _____.

0

Calvin, Allen (Project Director) (S) CRP

Plane Geometry. Encyclopaedia Britannica Films, Inc., copyright 1960. Programmed textbook, $16.75. (Preliminary edition for testing only—1514 pages, 11,027 items, 2 parts.)

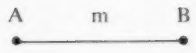
1. The basic objects of plane geometry are points and lines. For example, in the figure to the right, which is a triangle, there are _____ (no.) lines and they are called the sides of the triangle.

3

2. Points are commonly referred to by capital letters. On the line to the right, *A* and *B* would refer to two different _____ (wd).

points

3. Lines are frequently referred to by small letters. In the figure to the right, m is a _____ (wd) passing through the two points A and B.

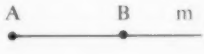


line

4. A line may also be referred to by two points on it. In the figure to the right, "line m" and "line AB" are two names for a line which passes through the two points _____(let.) and _____ (let.)

A, B

5. A line may be extended indefinitely in either direction. A line segment is that portion between two of its points. In the figure to the right, we would say that _____ (lets.) is a segment of line m.



AB

* * *

1060. Write in the correct reason 3. Statement 4 is the statement to prove, "_____." Write this statement 4 on the Figure 132. Check the response column to see if you have written in the correct statement 4.

$AC = BC$

1061. Reason 4 is, "_____." Write in reason 4 in the reason column of Figure 132. Check the response column to see if you have written in the correct reason.

corresponding parts of congruent triangles are equal

1062. We have now completed two theorems, each of which is the converse of the other. The first theorem was, "If a triangle is isosceles, the _____ _____ are equal."

base angles

Calvin, Allen (Project Director) (S) CRP

Second Year High School Algebra. Encyclopaedia Britannica Films, Inc., copyright 1960. Programmed textbook, $12.75. (Preliminary edition for testing only—1106 pages, 6746 items, 2 parts.)

1. Letters are very often used in algebra to represent numbers. The name *literal number* is given to any letter which stands for a number. Suppose we let x represent the number of days in a week. Then, x stands for the number 7 and x is a _____ number.

literal

2. Suppose we let t represent the number of seconds in a minute. Then, t is a literal number because it is a letter which stands for the number _____.

60

3. The symbols $a + 8$ means that we are supposed to add the humber a to the number 8. The number a is a _____ _____.

literal number

4. The symbols x = y represent the number which is the result of adding the literal number x to the literal number _____.

   y

5. The answer to any addition problem is called the sum. If the number x is equal to a + b then x is the _____ of a and b.

   sum

6. What is the sum of 7 and 3? _____.

   10

* * *

916. Statement (2) says that m is an integer. Statement (3) says that n is an integer. If k = m + n, then k is the sum of two integers, and therefore k is an _____. (Statement 7)

   integer

917. We know from (6) that M + N = 2 (m + n). In (7) we let k equal m + n. We may thus substitute k for m + n in the statement (6). That is, M + N = 2 _____. (Statement 8)

   k

918. By definition, an even number is any number which can be put in the form 2k, where k is an integer. M + N can be put in the form 2k by statement (8), and k is an integer by statement _____. It is thus true that M + N is an even number; and this is what we wanted to prove.

   (7)

Calvin, Allen (Project Director) (S) CRP

Solid Geometry. Encyclopaedia Britannica Films, Inc., copyright 1960. Programmed textbook, $9.75. (Preliminary edition for testing only—342 pages, 1912 items, 1 part.)

1. The study of solid geometry is the study of the similarities and differences of solid geometrical figures. That is, figures which for the most part do not lie in a single plane. Sometimes we refer to such figures as three dimensional figures. Figure 1 shows a sphere lying on a plane. A sphere is a _____ dimensional figure.

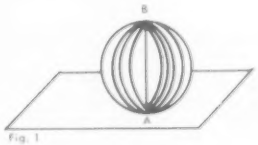


Fig. 1

   three

2. When we say that a sphere is a three dimensional figure, we mean that a sphere occupies space. It is a solid object. We may describe this solid property of the sphere by saying that a sphere has a volume. In Figure 1, the points A and B on the sphere lie at opposite ends of a line passing through the center of the sphere. Such a line is called a diameter of the _____.

   sphere

3. The line AB in Figure 1 is a _____ of the sphere.

   diameter

4. If we cut a sphere in half, each of the halves are called hemispheres. Obviously,

the volume of either hemisphere is _____ the volume of the whole sphere.

one-half

* * *

621. *Theorem 3:* Two lines perpendicular to the same plane are _____. *Given* (Figure G6 supplementary book); Lines *AB* and _____ are perpendicular to plane *p*.

parallel *CD*

622. *To Prove:* AB||_____.

CD

623. *Construction:* Join the feet of lines *AB* and *CD*. This gives us line _____ in plane *p*.

BD

624. Draw line *EF* in plane *p* perpendicular to line *BD* so that *D* is the mid-point of *EF*. That is, ED = _____.

DF

625. Then draw the following lines: *AE*, *AD*, *AF*, *BE*, and *BF*. This completes the construction. The lines passing through *D* perpendicular to line *EF* are: lines *BD* (by construction) and _____ (given).

CD

Calvin, Allen (Project Director) **(S) CRP**

Trigonometry (High School). Encyclopaedia Britannica Films, Inc., copyright 1960. Programmed textbook, $12.75. (Preliminary edition for testing only—1028 pages, 4516 items.)

1. We are going to start by classifying kinds of numbers we can think of. Probably the most common kind of numbers are the positive whole numbers or the positive integers, such as 1, 2, 3, and so on. The number 4 is the next positive integer in the sequence, and the next number after 4 is the positive integer _____.

   5

2. Probably the next most common kind of numbers are the negative whole numbers or negative integers. Examples of these are −1, −2, −3, and so on. The next negative integer in this sequence after −3 is −4, and the next negative integer after −4 is _____.

   −5

3. We also have the number 0 (zero). We remember that if we add 0 to any number then the answer is still the number we started with. That is, 5 + 0 = _____.

   5

4. −3 + 0 = _____.

   −3

5. −4 is an example of a negative integer. −5 is an example of a negative _____.

   integer

* * *

603. We see that the graph of the function $y = -x$ lies in the second and fourth quadrants. Thus, by looking at the graph, we can see that when x is negative, y is _____ and when x is positive, y is _____.

positive *negative*

604. We are now going to plot the graph of the function $y = |x|$. First, let us recall a few properties of the absolute value of x. Remember that the absolute value of a number is a measure of the distance of that number from the _____.

origin

605. Since the absolute value of a number is its distance from the origin, the absolute value of any number is positive. Thus, for example:
$|2| = 2$ and $|-2| =$ _____. (Therefore $|-2| = |2|$)

2

606. We remember that if a is positive, that is, if $a>0$, then _____ $= a$. Also, $|0| =$ _____.

$|a|$, *0*

Crowder, Norman, and Martin, Grace C. (S, C, A) MCP

Adventures in Algebra. Santa Barbara, California: Western Design & Electronics, Division of U. S. Industries, Inc. Published by Doubleday and Co., copyright 1960. Tutortext, Vol. I, $3.95. Length, 350 pages.

CHAPTER 9—NUMBERS WITHOUT NUMBER

Tutortext Page 303

We have seen how the multiplication of literal numbers lead to expressions in which quantities appear "squared." For example, if we multiply $(a + b)$ by $(a - b)$, we get

$$(a + b)(a - b) = a^2 - b^2$$

It may have occurred to you that there are also equations in which the unknown quantity appears "squared." For example, we might have the equation

$$x^2 - 4 = 0$$

which we are required to solve for x. Now, before we barge right ahead into this subject, let's stop to recall what we mean by "solving an equation," or, in this partcular case, "solving for x." What do we do when we solve the equation

$$x^2 - 4 = 0?$$

We find the numerical value of x that will make the equation true. Page 306. We substitute a numerical value for x to see what the equation is equal to. Page 309.

* * *

Tutortext Page 306

Your answer: *We find the numerical value of* x *that will make the equation true.*

You are correct. Of course, if we have literal instead of numerical values in the equation with our unknown x, we solve for x in terms of the literal numbers. For example, we say that if $ax + b = 0$, then

$$x = \frac{-b}{a},$$

where a and b are any numbers, but $a \neq 0$. Very well, now let's consider solving the equation $x^2 - 4 = 0$ for x.

$$x^2 - 4 = 0$$
$$\text{So} \qquad x^2 = 4$$

Now, recall that the symbol x^2 simply means "x multiplied by x." What value of x will make the equaton $x^2 = 4$ true?

+2, but not −2. Page 310
−2, but not +2. Page 313
+2 or −2. Page 316

* * *

Tutortext Page 309

Your answer: *We substitute a numerical value for* x *to see what the equation is equal to.*

Each side of the equation is equal to zero. It says so. What we want is a value of x that will make the equation true. We don't find this by trying one number after another. We have developed techniques that enable us to solve equations without guessing. And, by following the rules and using these techniques, we find the numerical value of x that makes the equation true. Finding this particular value of x is called "solving" the equation. Now go back to page 303 and choose the right answer.

DeBaca, Polo C., and Tosti, Donald (E) CRP

Time Telling. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1961. Published by TMI-Grolier, machine format, $5. Length, 450 frames.

96. 12 — 5 — 10 — 15 — 20 — 25 — 30
Count by 5's. 5 10 15 20 25 ( )
30

97. 12 — 5 — 10 — 15 — 20 — 25 — 30
Count by 5's. 5 10 15 ( ) ( ) ( )
20 25 30

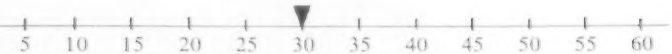
98. 12 — 5 — 10 — 15 — 20 — 25 — 30
5 ( ) ( ) ( ) ( ) ( )
10 15 20 25 30

99. 12 — 5 — 10 — 15 — 20 — 25 — 30
( ) ( ) ( ) ( ) ( ) ( )
5 10 15 20 25 30

100. 12 — 5 — 10 — 15 — 20 — 25 — 30

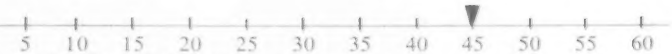
Count by 5's. The LONG hand points to ( )

20

101. 12 

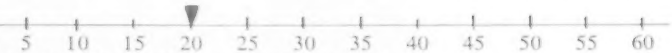
Count by 5's. The LONG hand points to ( )

30

102. 12 

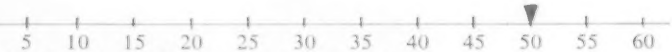
Count by 5's. The LONG hand points to ( )

45

103. 12 

Count by 5's. The LONG hand points to ( )

20

104. 12 

Count by 5's. The LONG hand points to ( )

50

105. 12

Count by 5's. The LONG hand points to ( )

35

Eigen, Lewis D. (S) CRP

Modern High School Mathematics I—Sets, Relations and Functions. New York: The Center for Programed Instruction. Copyright 1960, Lewis D. Eigen. Books I, II, and III of *Sets, Relations and Functions* available for research purposes only to individual educators, researchers, and schools, $5. Entire program, *Modern High School Mathematics I* (7000 frames) including *Sets, Relations and Functions* (800 frames), available in September 1961 only to schools for experimental purposes.

S-397 $\{1,2,3\}$ and $\{8,9,10\}$ are both sets. We can construct a relation which matches $\{1,2,3\}$ with $\{8,9,10\}$. It is $\{(1,8), (2,9), (3,\square)\}$.

10

S-398 Another way of matching $\{1,2,3\}$ with $\{8,9,10\}$ would be: $\{(1,10), (2,9), \square\}$

(3,8)

S-399 To match $\{1,2\}$ with $\{a,b\}$ we could write: $\{(1,a), \square\}$.

(2,b)

S-400 Another way to match $\{1,2\}$ with $\{a,b\}$ would be: $\{(1,b), \square\}$

(2,a)

S-401 There are two ways of matching $\{5,7\}$ with $\{0,1\}$. One is: $\{(5,0), (7,1)\}$ The other is: $\square$

$\{(5,1), (7,0)\}$ or $\{(7,0), (5,1)\}$

S-402 There are [ ] relations which match {a,b} with {r,t}.

2

S-403 Write all the relations which match {a,q} with {r,z}: [ ]

{ (a,r), (q,z) } and { (a,z), (q,r) } or equivalent.

S-404 Let X = {1,5} and let Y = {9,11}. Let R = {(1,9, (5,11)}.
R matches X with Y. Domain R = X and Range [ ] = Y

R or {(1,9), (5,11)}

* * *

S-591 Let V = { (x,y) | y = x + 2}. V(2) = 4. We call 4 the *image* of 2.
V(0) = 2. The *image* of 0 is [ ].

2

S-592 Let T = {(r,b) | b = r − 3}. T(5) = 2. 2 is the *image* of [ ].

5

S-593 Let P = { (3,5); (7,1) } [ ] is the *image* of 3.

5

S-594 Let Q = { (a,b) | a = b + 7}. 9 is the [ ] of 2.

image

Evans, James L. (E, S, A) CRP

Squaring Two-Digit Numbers Ending in 5. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1960. Published by TMI-Grolier, sample program, 25 cents. Length, 25 frames.

1. To square a number, multiply it by itself. Example: To square 3, multiply 3 times 3. The answer is 9. Also: To square 6, multiply 6 times 6. The answer is ——.

   36

2. The square of 8 is: 8 times 8, or 64. The square of 5 is: 5 times 5, or ——.

   25

3. The square of 7 is 49. The square of 3 is ——.

   9

4. The square of 4 is ——.

   16

5. When you count, the number that comes next after a number is called the FOLLOWER of that number. The follower of 4 is 5. The follower of 6 is 7. The follower of 8 is ——.

   9

6. The follower of 9 is 10. The follower of 2 is ——.

   3

7. The follower of 6 is ——.

   7

8. A number and its follower can be multiplied together. Multiplying 7 and its follower gives: 7 times 8, or 56. Multiplying 5 and its follower gives: 5 times 6, or ———.

   30

9. Multiplying 1 and its follower gives: 1 times 2, or 2. Multiplying 2 and its follower gives: 2 times ———, or ———.

   3 6

10. Multiplying 4 and its follower gives: ——— times ———, or ———.

    4 5 20

11. You are going to learn an easy way to square two-digit numbers which end in 5. 35 is an example of a two-digit number which ends in ———.

    5

12. To square a two-digit number ending in 5, first find the left digit. In 45, the left digit is 4. In 75 the left digit is ———.

    7

13. In 85, the left digit is ———.

    8

14. Next, multiply the left digit times its follower. Example: For 65, multiply the left digit 6, times its follower, 7, and get 42. Also: For 25, multiply 2 times ———, and get ———.

    3 6

15. For 35, multiply ——— times ———, and get ———.

    3 4 12

16. After multiplying the left digit by its follower, write down the result: For 65, write down 42. For 45, write down 20. For 25, write down ———.

    6

17. After writing down the result of multiplying the left digit times its follower, write 25 after it. Example: For 35, write 12, and then write 25 to get 1225. Also: For 45, write 20 and then write ——— to get 2025.

    25

Gagne, Robert M. (E, S) CRP

Quinary Numbers. New Jersey: Department of Psychology, Princeton University, 1960. Available only to qualified researchers. Length, 117 frames.

42. Now, here is something new. Suppose we should make up a number system which uses only five different digits. These digits are: 0, 1, 2, 3, 4. (This means we can never use the digits 5, 6, 7, 8, 9, to represent any number.) What is the largest number we can represent with a single digit? ———.

43. If we use the digits 0, 1, 2, 3, 4, *four* is the largest number we can use to represent a single digit. If four is the largest one-digit number, how can we represent *five?* We have to use ——— digits.

44. Digits: 0, 1, 2, 3, 4. To represent *five*, we must use *two digits*. This would be the two digits 10.

Numbers:	zero	one	two	three	four	five	six	seven
Five-Digit System:	0	1	2	3	4	10	11	——?

How is the number seven represented ——?

45. Let's count further using the five-digit system. Zero, one, two, three, four, five, six, seven, eight, nine, ten. 0, 1, 2, 3, 4, 10, 11, 12, 13, 14, *20*. Notice when we get to *ten*, we can't put down 1 and 5, because there is no digit 5 in this system. So *ten* becomes 20, *eleven* is 21, and *twelve* would be ——?

46. Now, start with the representation of ten in the five digit system: ten (20), eleven (21) twelve (22), thirteen (23), fourteen (24), fifteen (30). Notice again, that when we get to *fifteen*, we have to increase the second digit again. Fourteen (24), fifteen (30), sixteen (31), seventeen ——?

47. Continuing the five-digit system: seventeen (32), eighteen (33), nineteen (34), twenty (40), twenty-one (41), twenty-two (42), twenty-three (43), twenty-four (44), twenty-five (100). When we get to the number *twenty-four*, we have the largest *two-digit number* in this system. Therefore, twenty-five must be 100, or the first —— —— number.

48. Now we have to learn how to speak of these digits in the five-digit system, to distinguish them from those of the old ten-digit system. Whenever we are talking about the five-digit system, we shall put a small 5 to the right, like this: 3_5 is pronounced *three lower five;* 4_5 is pronounced —— —— ——.

49. We can also use a *small 10* when we are talking of the ten-digit system. 2_{10} is pronounced *two lower ten;* 3_{10} is pronounced —— —— ——.

50. We know that $3_{10} = 3_5$. The number *three* is represented by the same digit in both systems. Three lower ten equals —— —— ——.

51. When we use two-digit and three-digit numbers, we also *pronounce each digit*. 10_{10} is pronounced *one-oh lower ten*. 10_5 is pronounced *one-oh lower five*. 20_5 is pronounced —— —— —— ——.

Gere, Brewster H., and Van Alstyne, John P. (C) CRP

Calculus and Analytic Geometry. Clinton, New York: Hamilton College. Copies of this program are not available. Length, about 1500 items.

The following excerpts from lesson units are examples of self-instructional materials used at two different stages in a course of calculus and analytic geometry.

UNIT 27

1. The elements of a coordinate system are (1) a point of reference, (2) directions, (3) distances. The origin is the ——.

   point of reference

2. In the polar coordinate system, the point of reference is the ——, sometimes called the pole.

   origin

3. If a line extends away from the origin this line, or "half-line," is called a ray. If the ray is rotated about the origin to a new position, the amount of rotation is the —— the ray in the new position makes with the ray in the original position.

   angle

4. An angle is the amount of _____ necessary to bring one of two rays which meet at a point called the vertex, into coincidence with the other ray.

   rotation

5. Counterclockwise rotation of a ray generates or produces a _____ angle.

   positive

UNIT 12

1. If $y = 6x^2$, then $y' = 12x$. If $y = 6x^2 + 5$, $y' = 12x$ and if $y = 6x^2 - 20$, $y' = 12x$. If $y =$ _____ $+ C$ where C is any constant, $y' = 12x$.

   $6x^2$

2. If $y = x^3 - 2x + 5$, then $y' = 3x^2 - 2$. If $y = x^3 - 2x - 2$, then $y' = 3x^2 - 2$. If $y =$ _____ $+ C$ where C is any constant, then $y' = 3x^2 - 2$.

   $x^3 - 2x$

3. If $y = 3x + 2$ or if $y = 3x$ or if $y = 3x - 100$, then $\frac{dy}{dx} = 3$. If $y = 3x + b$, where b is any constant, $\frac{dy}{dx} =$ _____.

   3

4. If $y =$ _____ $+ b$, where b is any constant, then $\frac{dy}{dx} = 5$.

   5x

Glaser, Robert; Schaefer, Halmuth H.; and Holzman, Albert (C, A) CRP

Mathematical Bases for Management Decision-Making. Department of Psychology, University of Pittsburgh, copyright 1961. Copies of this program are not available. Length, 4000 frames.

48. In working with matrices we will often be dealing with sums of rows and columns. It will be convenient for us to utilize a shorthand method for designating sums. We shall use the Greek letter Σ (read sigma) to indicate a sum. When we use Σ a _____ is indicated.

    sum

49. With simple summation we have little use for Σ. When we see $1 + 2 + 3 + 4$ we can give the answer which is _____.

    10

50. But suppose all the values in a summation are unknown. If we see $x_1 + x_2 + x_3 + x_4$ we (can/cannot) _____ give an answer.

    cannot

56. An index is like a house number. It says nothing about the size of the house but just where it is located on a street. The index "5" in x_5 says nothing about the size of _____.

    x_5

57. The index "5" in x_5 merely shows that x_5 comes between x_4 and _____.

x_6

117. In $\sum_{j=0}^{3} x_{j+1}$ the initial value of j is _____.

0

187. $\sum_{j=1}^{6} x^j = x + x^2 + \ldots + x^5 + x^6.$

$\sum_{j=2}^{12} x^{2j} =$ ____ + ____ + . . . + ____ + ____.

$x^2 + x^6 + \ldots + x^{22} + x^{24}$

188. $\sum_{j=3}^{9} jx^{2j} =$ ____ + ____ + . . . + ____ + ____.

$3x^6 + 4x^8 + \ldots + 8x^{16} + 9x^{18}$

Keislar, Evan (E) MCP

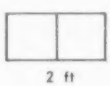
Areas of Rectangles, Fifth Grade. Los Angeles: University of California. Microfilm copy available under Order Document Number 6080, American Documentation Institute, Auxiliary Publication Service, Library of Congress, Washington 25, D.C., $2. Length, 120 frames.

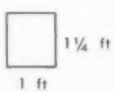
18. Squares can be large or small. But if each side on a square is one foot long, this is called a square foot. Which figure is one square foot?

A.

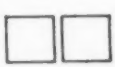
B.

C.

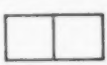
D. 

E. 

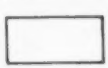
19. Here are two squares. They are exactly the same size.



Suppose I put the squares together side by side like this:

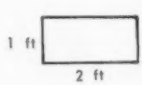


What kind of a figure will the two squares together make if I leave out the middle line like this?

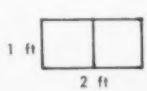


A. Another bigger square
B. A rectangle

20. Here is a rectangle. It is 2 feet long and 1 foot wide.

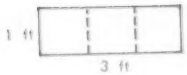


Suppose I draw a line in the middle like this: I will make 2 squares. How long will each side of each square be?



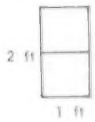
A. 1 ft.
B. 2 ft.
C. 3 ft.

21. Suppose you have a rectangle which is 3 feet long and 1 foot wide like this:
How many squares, 1 foot long on each side, can I make out of this rectangle?



A. One
B. Two
C. Three

22. How many square feet are in a rectangle which is two feet high and one foot wide like this:



A. One
B. Two
C. Three
D. Six

Moon, Harold, and Moon, Gwendolyn (E) CRP

Signed Numbers. Institute of International Research and Development, Box 4456, Lubbock, Texas. Copyright 1960. Programmed booklet, 50 cents. Length, 100 items.

1. A number that has a plus sign (+) in front of it is called a *positive* number. For example, +5, +16, +212 are positive numbers. Also, +4 is a _____ number. (Check your answer with the correct one given in the upper right-hand corner of item 2, page 2.)

   positive

2. A positive number has a _____ sign in front of it.

   plus

3. A number that has a plus sign in front of it is a _____ number.

   positive

4. +6 is a positive number, because it has a _____ sign in front of it.

   plus

5. +8, +3, +64, +928 are _____ numbers.

   positive

6. In algebra we use both positive and negative numbers. A number that has a (−) minus sign in front of it is a negative number. Therefore, −5 is a _____ number.

   negative

31. In 2 +2, the plus sign means "add" 2 and 2. When a plus sign is used to mean "add" and a minus sign is used to mean "subtract," they are called signs of operation. In 4 +3 and 5 − 2, the signs + and − are signs of _____.

   operation

32. In (−6) + (−3), the sign of operation is the _____ sign.

   plus

33. In (8) − (2) + (3) the plus and minus signs between the numbers are called _____ of _____.

signs (of) *operation*

34. The expression (−10) + (+8) means to add −10 and +8. The expression (−9) − (+4) means to subtract _____ from _____.

+4 (from) *−9*

35. The parentheses ( ) around the signed numbers, as in (+3) − (−2), are punctuation marks. These parentheses separate the signed numbers from the sign of (a) _____ in the center, which is a (b) _____ sign.

(a) *operation* (b) *minus*

Roe, Arnold and others (C) CRP

Algebra (College). Los Angeles: Teaching Systems Research Project, Department of Engineering, University of California. Available only to qualified researchers from the author. Length, 200 items.

1. So far we have studied how to calculate the probability of a single event, P (A), the probability of either one or another of two or more possible events, P (A or B) and the probability of joint events, P (AB). To calculate P (A or B), we _____ the probabilities of the events we are interested in. To calculate P (AB), we _____ the probabilities of the events A and B.

add *multiply*

2. We have also been concerned with the *ordered* arrangement of events. For example, in calculating P (AB) we have been concerned with the probability that first A then B would occur. If we want to know the probability that the first three letters of the alphabet will occur in a given order, we must know ALL the possible _____ arrangements of the first three letters of the alphabet.

ordered

3. The first three letters of the alphabet can be arranged in six different orders: abc, acb, bac, bca, cab, cba. As you can see, each of the six sets of letters contains the same 3 letters but in a different _____ arrangement.

ordered

4. If the number of objects or events to be ordered is small, one can make all the possible ordered arrangements, as we did with the first three letters of the alphabet, and count them. However, if the number of objects is larger, it is more convenient to calculate the number of possible ordered arrangements. In the case of the first three letters of the alphabet, this is done by $3 \times 2 \times 1 = 6$, which is the same _____ of possible ordered arrangements we prepared in the preceding item.

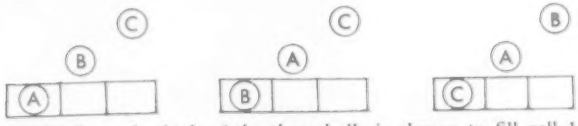
number

5. We calculated the number of possible ordered arrangements of the first three letters of the alphabet by $3 \times 2 \times 1 = 6$. To illustrate why this method is used, let us use three balls, labelled A, B, and C, and a box divided into three cells.

How many *different* balls we can choose from to fill cell 1?

3

6. Cell 1 can be occupied by ball A, or B, or C. There are then three different ways (balls) by which cell 1 can be filled. If we fill cell 1 in each of the three different ways it can be filled



we can see that regardless of *which* of the three balls is chosen to fill cell 1, when cell 1 is filled, there are _____ balls left from which we can choose to fill cell 2.

2

Shay, Carleton (E) MCP

Roman Numerals. Los Angeles: University of California. Unavailable except on library loan from UCLA. Length: large step program, 104 items; medium step, 150 items; small step, 199 items.

INSTRUCTIONS

1. Each page tells you something new and asks you a question. Two or three answers are given. You choose the right one.

   Where is this school?
   1. Japan
   2. California
   3. New York

   (Answers)

   California

2. Read the page carefully. If your answer is wrong, check to see if your punch is correct.

   What is 10 + 5 + 1?
   1. 14
   2. 15
   3. 16

   16

3. If you do not get a green light, read the page over and try again. Do not go on to the next page until you get a green light.

   What is 2 times 50?
   1. 52
   2. 100
   3. 150

   WAIT, DO NOT TURN THE PAGE

   100

PROGRAM

4. Roman numerals are letters. Each letter stands for a number. Can you count in Roman numerals? What is the letter for 1?

   1. V
   2. I
   3. X

I =	1
V =	5
X =	10

   I

5. To make a 2 we put two I's together: II.
What is number II.

1. I
2. 2
3. 3

2

6. If we add three I's together (I + I + I) to make III, what number is it?

1. I
2. 2
3. 3

3

7. Can you find 5 on the clock? What is the Roman number for 5?

1. I
2. X
3. V

V

8. We can add 1 to 5 to make 6: 5 + 1 = 6. We do this with Roman numerals too: V + I = VI. If we add V and I together what is the number we make?

1. 5
2. 6
3. 7

6

Silverman, R. E., and Alter, Millicent (S, C) CRP

Binary Numbers. University College of Arts and Sciences, New York University. Research conducted for the U. S. Naval Training Devices Center, NAVTRADEVCEN TR 507-3, Port Washington, Long Island, New York, 1960. Available to all government agencies. Length, 90 frames.

1. A digit is a symbol we use to indicate quantity. We use the symbol 6 to mean the quantity six. We use the symbol 9 to mean the quantity _____.

nine

2. It is possible to use other symbols. We use the digit 5 to represent the *quantity* five. The Romans used the symbol V to represent the quantity _____.

five

3. We use a "decimal" system which is based upon ten different *symbols* or, as we call them, digits. A digit is a _____ we use to indicate a given quantity.

symbol

4. The digit 6 represents the *quantity* six; the digit 4 represents the quantity four. The ten different digits we use each represents a different _____.

quantity

5. It is not necessary to use ten different _____ to indicate quantity. We might use only four or five different digits.

digits or symbols

6. In our system of numbering we use ten different symbols or digits, 0, 1, 2, 3, 4, 5, —, —, —, and — to indicate quantities from nothing to nine.

   6, 7, 8, and 9

7. As you will learn later on, the symbol 10 (read "one oh") may represent quantities *other* than ten; for example, two, five, seven. In our system, the decimal system, 10 represents the quantity _____.

   ten

8. *From now on,* when we are referring to quantity we will write it out in words so that we can distinguish it from its symbol.

Decimal number	*Quantity*
10	ten
17	(a) _____
20	(b) _____

   (a) *seventeen* (b) *twenty*

9. When we are referring to the numerical symbol for a given quantity, we will write the number, not the word.

Decimal number	*Quantity*
10	ten
(a) _____	seventeen
(b) _____	twenty-five

   (a) *17* (b) *25*

Smith, Edgar A. (E, Sp.Ed.) Matching MCP

Elementary Arithmetic. Devon, Pennsylvania: The Devereux Foundation. Copyright 1960, Edgar A. Smith. Published by Devereux Teaching Aids (spiral bound workbooks for use on Devereux Teaching Aid Model 50, $1.50 each). Length, 35 workbooks, approximately 150 items per booklet.

(Matching type program. Student matched process, computation, and solution to problem situations. This is not a self-sufficient straight line program; they are workbooks designed to supplement other forms of classroom instruction and are primarily designed to afford additional practice in fundamentals.)

Problem	*Process Used*	*Computation*	*Solution*
If you have a dollar, and spend 65 cents for a movie ticket and ten cents for a "coke," how much will you have left?	add then subtract	$2\overline{)15}$	10¢
How much would three dime "cokes" cost?	add	$2\overline{)20}$	30¢
If you and a friend share a 20-cent bag of popcorn, how much should each pay?	multiple	65¢ 10¢	65¢
How much does a 30-cent hamburger and a dime "coke" cost?	subtract	30¢ 10¢	25¢

If pencils cost two for 15 cents, how much does one cost?	divide	\$1.00 .35	8¢
If you have a dollar and spend 35 cents, how much change should you get?	divide and round	10¢ 3	40¢

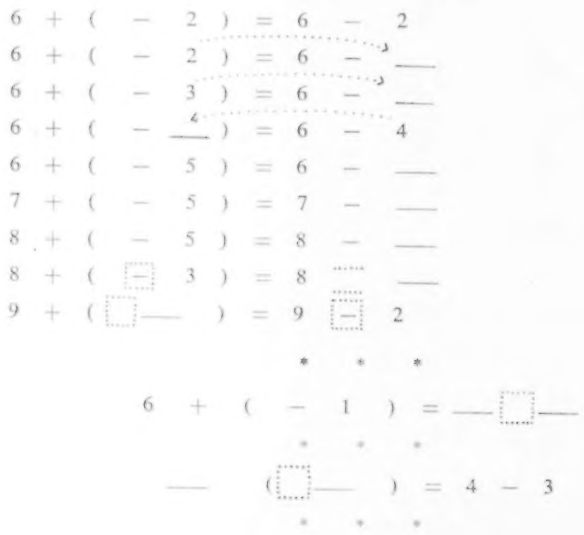
Smith, M. Daniel (E) CRP

Adding Directed Numbers. Cambridge: Harvard University. Copies of this program are not available. Length, still undetermined.

Sub-Behavior I: $a + (-b) = a - b$ if $a > b > 0$. This program is to be standardized and optimum length investigated as a function of number of examples given for each step (one example of each step is given below).

SECTION 1

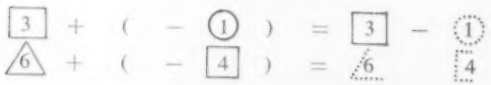
Student fills in blanks

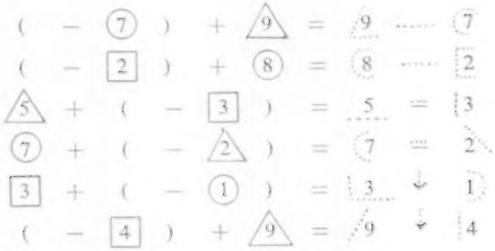


(Through review of commutative property and transitive property, student finds also that the following is true: $(-2)+8=8-2$. The next section leads to a general expression of this process.)

SECTION 2

(The student draws in geometrical shapes where they are dotted or missing.)





DON'T WRITE IN MISSING NUMBERS

* * *

If △ > □ > ○ , then △ + (− □) = _____

○ + (− △) = ○ − △ if _____

* * *

WRITE IN SHAPES AND LETTERS

* * *

(In this final sequence, student fills in the letters only, *not* the shapes.)

* * *

Smith, Robert G., Jr., and Moon, Harold (C) CRP

Personal Tutor in Algebra. National Teaching Machines, Box 4016, El Paso, Texas, copyright January 1959. Programmed text, $5.50. Length, over 2000 items and 13 reference sections in a separate booklet.

REVIEW OF ELEMENTARY ALGEBRA: I

(104 items)

1. 2 + 4 = 6; also, 4 + 2 = ?

   6

2. 9 = 4 + 5; also, 9 = 5 + ?

   4

3. a + b = c; also, b + a = ?

   c

4. x = y + z; also, x = z + ?

   y

5. It makes no difference which number is added first. This is the *commutative* law of addition. This law says that b + a = a + ?

   b

COMBINATIONS AND PERMUTATIONS

(39 items)

1. A *permutation* is an ordered arrangement of a group of objects or events. The letters x, y, and z, taken three at a time, can be arranged in six different ways: xyz, xzy, yxz, yzx, zxy, zyx. Each of these orders is a _____.

   permutation

2. If we want to know the number of permutations, or orders, in which two events can occur, we must first know in how many ways each event can occur; e.g., if we want to know how many ways a person can enter and leave a building, we must first know how many entrances and exits there are. If there are six entrances and four exits, then there are (6) (4) different ways in which one can pass through the building. Each of these ways is a permutation. If an act can be done in three ways, such as entering a building, and another act can then be done in two ways, such as leaving the building, how many different ways can each act be done in order?

   six

3. If an act can be done in *x* ways, and if after it is done a second act can be done in *y* ways, then the two acts can be done in order _____ different ways.

   xy

4. If a coat can be put on in three ways and can then be taken off in two ways, how many ways can the coat be put on and taken off?

   six

Tosti, Donald (E) CRP

Multiplication and Division Facts. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1961. Published by TMI-Grolier, programmed textbook and machine format, $10. Length, 2000 frames.

1. Here are the factors: 9, 9, and _____. Write the divisive equation.

   [*81 ÷ 9 = 9*]

2. Here are the factors: 7, ___, and 70. Write the multiplicative equations.

   [*7 × 10 = 70*] [*10 × 7 = 70*]

3. Here are the factors: 7, _____, and 70. Write the divisive equations.

   [*70 ÷ 10 = 7*] [*70 ÷ 7 = 10*]

4. Here are the factors: 2, _____, and 16. Write the multiplicative equations.

[$2 \times 8 = 16$] [$8 \times 2 = 16$]

5. Here are the factors: 2, ____, and 16. Write the divisive equations.
   [$16 \div 8 = 2$] [$16 \div 2 = 8$]
6. Here are the factors: 8, 9, and ____. Write the multiplicative equations.
   [$8 \times 9 = 72$] [$9 \times 8 = 72$]
7. Here are the factors: 8, 9, and ____. Write the divisive equations.
   [$72 \div 9 = 8$] [$72 \div 8 = 9$]
8. Here are the factors: 7, 9, and ____. Write the multiplicative equations.
   [$7 \times 9 = 63$] [$9 \times 7 = 63$]
9. Here are the factors: 7, 9, and ____. Write the divisive equations.
   [$63 \div 9 = 7$] [$63 \div 7 = 9$]
10. Here are the factors: ____, 10, and 70. Write the multiplicative equations.
    [$7 \times 10 = 70$] [$10 \times 7 = 70$]
11. Here are the factors: ____, 10, and 70. Write the divisive equations.
    [$70 \div 10 = 7$] [$70 \div 7 = 10$]
12. Here are the factors: ____, 8, and 16. Write the multiplicative equations.
    [$2 \times 8 = 16$] [$8 \times 2 = 16$]
13. Here are the factors: ____, 8, and 16. Write the divisive equations.
    [$16 \div 2 = 8$] [$16 \div 8 = 2$]
14. Here are the factors: 9, ____, and 81. Write the multiplicative equations.
    [$9 \times 9 = 81$]
15. Here are the factors: 9, ____, and 81. Write the divisive equation.
    [$81 \div 9 = 9$]

■ MUSIC

Chakerian, Lan, and Ventolo, William (E, S, C, A) CRP

Fundamentals of Music. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1961. Published by TMI-Grolier, programmed textbook and machine format, $7.50. Length, 700 frames.

26. An easy way to show that note-names repeat themselves from A to G is by this diagram: Read the letters clockwise. The note-name that follows A is (sym)____.

B

27. The note-name after F is (sym)____.

G

28. The note-name after G is (sym)———.

A

29. Once the seven note-names have been used up, they begin to repeat. Fill in the next four note-names after F: A B C D E F (syms) — — — —.

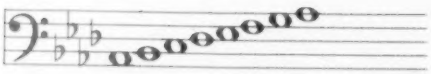
G A B C

30. Name the remaining white keys on this keyboard: C D (syms) — — — — — —.

E F G A B C

* * *

681. Which notes are played flat? (nbrs) — — — — —



1 2 4 5 8

682. The key signature shown is in the key of (sym) —— (wd) ————.

F major

683. To name the key when sharps make up the key signature, count a (wd) ——— step up from the last sharp. When flats make up the key signature, the next to (wd) ——— flat is the name of the key.

half; last

684. (1) is in the key of (sym)—— (wd) ————. (2) is in the key of (sym) —— (wd) ————.

(1) (2)

G major; D major

685. (1) is in the key (sym) ____ (wd) _____. (2) is in the key of (sym) ____ (wds) _____ _____.

(1) (2)

F major; B flat major

Gillespie, James (S, C) CRP

Fundamentals of Music. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1960. Copies of this program are not available. Length, 455 frames.

1. If you can read and understand words you can read and understand music. The primary sounds of music are *tones*. When you sing a song, the sounds you make are (wd) _____.

   tones

2. The primary sounds of music are (wd) _____.

   tones

3. Sounds come from the vibration of an object. For example, the sound of our speech comes from the vibration of our vocal chords. Also, the sounds from a guitar come from the (wd) _____ of the strings.

   vibration

4. The sound of a violin comes from the (wd) _____ of the strings.

   vibration

5. The primary sounds of music are (wd) _____.

   tones

6. The pitch of a sound is the same as its "highness" or "lowness." For example, the pitch of a foghorn is lower than the pitch of a police whistle. Also, the sound of a tone from a violin has higher (wd) _____ than the sound of a tone from a bass violin.

   pitch

7. The sound of a trombone is different from a flute. The trombone produces sounds, or tones, of a lower (wd) _____ than the flute.

   pitch

8. The faster the vibration of an object, the higher the pitch of the sound. The strings on a violin vibrate (faster/slower) _____ than the strings of a bass violin.

   faster

9. When you strike a glass and hear a ringing sound, this is due to the (wd) _____ of the glass.

vibration

10. The vibrations produced by a trumpet are (wd) _____ than the vibrations produced by a tuba.

faster

* * *

451. I. is in the key of (wds) _____ II. is in the key of (wds) _____

A♭ major *G major*

Gillespie, James (C) CRP

Some Fundamentals of Music. Department of Psychology, University of Pittsburgh, July 1958. Copies of this program are not available. Length, 44 frames.

Step 33 Response Panel

A *tie* is also used to lengthen the tone length of a note, but it has a more general property than a dot which we learned lengthened a note by _____ its original value. A tie sustains the value of the first note the length of the second. For example, write the three following equations using only one note, i.e., use only one note to complete the equation.

1. = (b)
2. = (c)
3. = (d)

Step 33 Check Panel

one half or ½

1. =
2. =
3. =

* * *

Step 34 Response Panel

As a brief review, we have first learned how to name the (a) basic tones using (b) letters of the alphabet and a (c) s_____ called (d) and (e). Next, we used a (f) with 5 lines and 4 spaces as a place to put the notes. To limit the range at which a series of notes are to be played we used c (g), the four basic kinds of being: 1. (h), 2. (i), 3. (j), and 4. (k). The next step was to limit the tone length by using 6 kinds of notes. These 6 kinds of notes also had corresponding rest signs. Indicate the note and corresponding rest sign for each of the 6 kinds of notes.

1.	(a)	(b)
2.	(a)	(b)
3.	(a)	(b)
4.	(a)	(b)
5.	(a)	(b)
6.	(a)	(b)

Step 34 Check Panel

(a) 12
(b) 7
(c) accidental signs
(d) sharps
(e) flats
(f) staff
(g) clef signs
(h) treble
(i) alto
(j) alto
(k) bass

1. (a) (b)
2. (a) (b)
3. (a) (b)
4. (a) (b)
5. (a) (b)
6. (a) (b)

* * *

Step 35 Response Panel

When music is written the staff is separated into *bars* or *measures*. Each bar or measure must have an equal time value, but since we have six different kinds of notes and dotted notes and *ties* and *rests*, ... there are a great number of possibilities for each bar. These many different possibilities can be used as long as the total time values in each bar or measure is equal to every other bar or measure. To indicate bars, lines are drawn through the staff as follows,

One can identify different types of songs by the number of bars used, e.g., standard popular songs have 32 bars, the "blues" have 12 bars. One rule to be observed is that the total time value for each bar must be _____.

Step 35 Check Panel

equal

Holvick, Leonard (C) CRP

Interval Sequence. Richmond, Indiana: Earlham College. Project coordinator, John A. Barlow. Copyright 1961, Earlham College. Available only to qualified researchers. Length, 5 lessons accompanied by tapes.

1. Sound comes to the ear in the form of sound waves (vibrations) carried in the _____.

air

2. In one _____ wave the vibrations may be rapid or of high frequency. In another the speed of vibration may be slower or of lower _____.

   sound *frequency*

3. Vibrations of different speed or frequency cause a different sensation in the hearer. We usually describe the extremes of this sensation as _____ or low. People say such things as: "She sang a very high note." "That's too low for me to sing." "The piccolo makes a shrill sound."

   high

4. A sensation of highness is caused by a _____ wave of high frequency. A sound somewhere midway between the extremes is caused by vibrations of moderate _____. Vibrations of low _____ cause a sensation of _____.

   sound *frequency* *frequency* *lowness*

5. The word "pitch" is used for this sensation of position, ranging from high to low. Sound waves of high frequency are high in pitch. Lower frequency produces lower _____.

   pitch

6. Instead of "She sang a very high note," we might have said, "She sang a note of very _____ _____."

   high pitch

7. When emphasis is on its relative highness or lowness, a musical sound itself is often called a pitch. Instead of, "She sang a very high note" we might have said, "She sang a very high _____."

   pitch

8. The word "pitch" is used not only for the sensation of position, ranging from high to low, but also for the individual musical sound which produces that sensation. We might say that a musical sound is low in pitch because it has low frequency. This might be said in abbreviated form thus: "This is a low pitch because it has a _____ frequency." We might also say: "This pitch has a frequency of 32." One may even encounter a further step in which "pitch" is used for the word "frequency" thus: "_____ 32."

   low *pitch*

■ PHYSICS

Keislar, Evan (E) MCP

Molecular Theory, First Grade. Los Angeles: University of California. Copies of this program are not available. Length, 132 frames.

(Special multiple choice program—2 choice; the choices are pictured by slides for the non-reading student. The text is presented aurally by tape.)

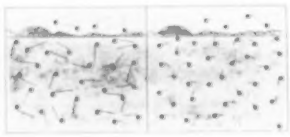
1. There is always water vapor in the air. Can you see water vapor in the air?

   Right! Of course not. Water vapor is a gas and so the molecules are too small and far apart to be seen.

2. In one of these pictures the molecules of air have been drawn. But in the other pictures no air molecules are shown. Does that mean that there is no air in this other picture?

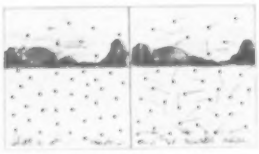
You're correct. You really can't see air but it is still there. Sometimes we draw dots or circles so you can see how molecules act.

3. After the sun sets, everything gets colder. Which picture shows that the air around the grass is cold?



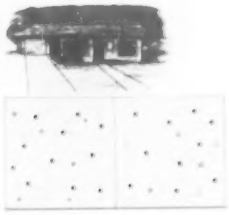
You're right. Molecules of air move slowly when the air is cold.

4. Besides air, there is water vapor near the grass. Which picture shows that air and water vapor cool down as the sun sets?



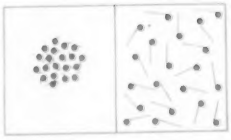
Right! The cool night slows down air and water vapor molecules.

5. During the night it is colder than it is during the day. In the day the sunlight warms everything up. Which picture shows air molecules and water vapor molecules during the night?



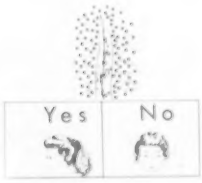
Right, since it is colder at night the air molecules move more slowly.

6. Which picture shows how the water vapor molecules would look after hitting something cold?



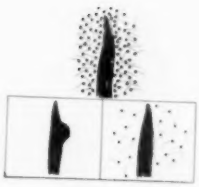
Yes, the water vapor molecules are attracted to each other when they are slowed down by something cold.

7. Here is a tiny blade of grass that is cooled when the sun goes down. Will the water vapor molecules go faster near the blade of grass?



Good for you! Because the grass is cool, the molecules will slow down near the blade of grass.

8. Here is a tiny blade of grass. The sun is setting and so the water vapor molecules near the blade of grass are slowing down. What happens to the water vapor when the molecules slow down? Which picture shows?



That's right! If water vapor slows down enough, the molecules will come together or condense.

9. The water molecules are attracted to each other on this cold blade of grass. What picture on the right shows a blade of grass which is warm?

Right! If a blade of grass is warm, molecules of water vapor aren't slowed down. They can't attract each other to form drops of water.

Klaus, David J., and others (S) CRP

High School Physics. Pittsburgh: American Institute for Research, copyright 1960. Available only to qualified researchers. Length, 2918 frames, covering 20 percent of a year-long high school course.

A-1 A very important discovery in physics was the mutual attraction of objects due to static electricity. If we rub a hard rubber comb with a wool cloth and hold it over bits of tissue paper, the comb will attract the paper. This attraction illustrates _____ electricity.

static

A-2 At parties, you have seen someone rub balloons against a wool rug to make the balloons stick to the walls or ceiling. This is another example of _____ _____.

static electricity

A-3 In _____ electricity, some objects will attract each other. A hard rubber comb rubbed against wool will _____ bits of tissue paper.

static *attract*

A-4 Still another example of static electricity can be seen when a piece of amber that has been rubbed with silk will _____ small objects.

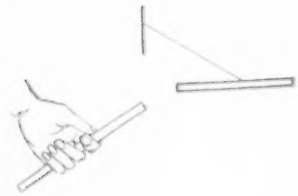
attract

A-5 Static electricity can also cause objects to *repel* each other. When a comb rubbed through fur is brought near another comb rubbed through fur, the combs will not attract each other, but will _____ each other.

repel

A-6 Knowing that two rubbed combs will repel each other, you would predict that two amber rods would also _____ each other after they have been rubbed.

repel



* * *

A-31 Two positive charges are "like charges" so they repel each other. A negative charge and a positive charge are _____ _____ and they attract each other.

unlike charges

A-32 The general rule is that _____ charges attract and _____ charges repel.

unlike like

A-33 The general rule for attraction and repulsion is that **_____. (note double asterisk indicates extended answer).

like charges repel and unlike charges attract (or you could say, *unlike charges attract and like charges repel*).

Mager, Robert F. (S, A) Special CRP

Meter Reading. Palo Alto, California: Varian Associates. Copies of this program are not available. Length, 200 frames.

This frame introduces the subject of "parallax," and is followed by 20 practice items. Though these frames are mounted on plastic pages 1/16" in thickness and provide practice relative to the parallax problem, they also provide review of other content items such as non-linear scales, multiple scales, and scales appearing in different positions, etc. Each item requires a response from the learner.

Page 139

New Idea

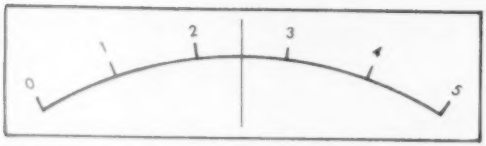
There is only one more thing you need to know about meter reading. It's simple, but important. Here's the rule: Always make sure you are directly in front of the pointer when reading a meter.

You see, when a pointer is *drawn* on the scale there is no question about *where* the pointer crosses the scale. BUT . . . meters are built so that the pointer does not touch the scale. And once the pointer is moved out and away from the face of the meter, the *reading* you get depends on *where* your head is in relation to the pointer.

Example

Look at the two identical scales below. The top one has the pointer *drawn* on it, just like others we have shown you so far. The other one has a pointer that has been *moved out* from the face of the meter. (We have exaggerated the usual distance between the scale and the pointer to illustrate our point.)

Looking at the top meter, move your head back and forth in front of it while looking at the pointer. Notice that no matter where you read from, the reading always looks like 2.5



Now, do the same thing while looking at the bottom meter. Note that the reading *changes* as your reading position changes. Your *reading* depends on your *reading position.*

For this illustration a photo of the meter face is attached to the rear surface of the plastic page, and a pointer is scribed on the front surface.

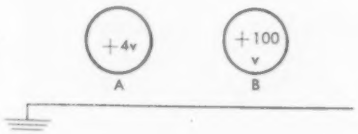
Tosti, Donald (S, A) CRP

Fundamentals of Electricity. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1961. Published by TMI-Grolier, programmed textbook and machine format, $10. Length, 1450 frames.

266. We use the word voltage to mean the same as potential. Ball A is at a potential of 6v. Another way of saying this is: Ball A is at a _____ of 6v.

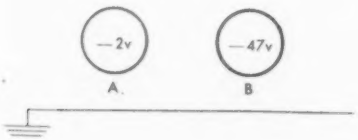
voltage

267. Ball A is at a + voltage to ⏚.
Ball B is at a (___) voltage to ⏚.



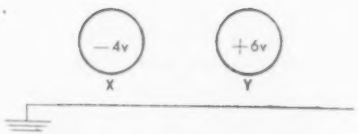
+

268. Ball A is at a — potential to ⏚.
Ball B is at a (___) potential to ⏚.



—

269. Ball X is at a (___) voltage to ⏚.
Ball Y is at a (___) potential to ⏚.

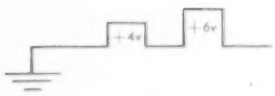


— +

270. Potential is measured in _____ or (___). (Give word & symbol)
The symbol for potential is (___).

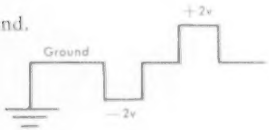
volts *v* *V*

271. We can think of the potential as a height. +6v is _____ than +4v.



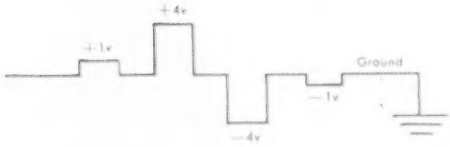
higher

272. A −2v is like a hole. It is lower than the ground. A +2v is like a height. It is _____ than the ground.



higher

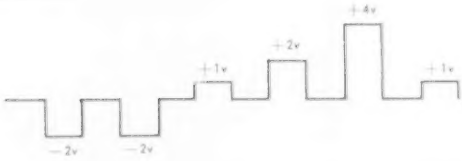
273. Which is the lowest voltage? _____



274. Which ball has the lowest voltage? _____

Ball C (−4v)

275. Which voltage is highest? _____



+4v

Woolman, Myron, and Valentine, C. G. (A) CRP

Basic Electricity. New York: Bell Telephone Laboratories, Inc. Project director, H. O. Holt. Copyright 1960, Bell Telephone Laboratories, Inc. Copies of this program are not available. Length, approximately 3500 constructed responses.

4. Everything has weight, even air and other gases. All objects that have weight are made up of atoms.
5. All material things which have _____ are composed of atoms.
6. *weight*
7. All things are composed of very small building blocks called ATOMS.
8. Copper, air, water, and all other solids, liquids, and gases are made up of _____.
9. *atoms*
10. Our bodies are made up of parts such as arms and legs; the atom is also made up of smaller parts.
11. All objects which have weight are composed of _____.
12. *atoms*

13. Every atom contains two important kinds of building blocks. These two kinds of atomic particles are called ELECTRONS and PROTONS.

14. All atoms contain _____ and _____.

15. *electrons* and *protons*

16. Electrons and protons are parts of _____.

17. *atoms*

18. Protons are in the center of the atom. Electrons circle or orbit around the protons.

19. Protons are in the center of the _____. _____ circle or orbit around the protons.

20. *atom* *Electrons*

21. Panel 1: A boy whirling a ball on a string over his head is like a simple atom. The boy is like the proton, and the circling ball is like an electron.

22. The simple atom can be compared to the sun and the earth: the proton is like the _____ and the electron is like the _____ which circles the sun.

23. *sun* *earth*

■ PSYCHOLOGY

Barlow, John A. (C) CRP

Introductory Psychology. Richmond, Indiana: Earlham College. Copyright 1961, John A. Barlow. Available only to qualified researchers. Length, 35 lessons (7 completed).

(From the general orientation of Reinforcement Theory, especially E. R. Guthrie's Contiguity Theory. This is an example of "conversational chaining.")

Instructions: Each item of this program (sequence of numbered parts or steps) contains a brief discussion with certain words or phrases omitted. Omissions are indicated by blank spaces: _____ *** _____ indicates more than one word omitted. The words or phrases given in capitals in the following item are the words or phrases omitted in the previous item. Fill in the blank spaces in an item before looking at the next item.

1. One indication of intelligence is the ability to profit from _____.

2. When we say that an individual has profited from "*EXPERIENCE*" (for instance, from TRAINING), we mean that he has _____ something from the "experience."

3. Everything LEARNED or GAINED from an "experience" does not turn out to be an improvement. We sometimes are in error and make _____ (which unfortunately we also may learn unless means are provided for *immediate* correction).

4. It is important to note that we sometimes make MISTAKES and learn these mistakes. Learning does *not* always result in an _____ in our knowledge or skill.

5. *IMPROVEMENT* (INCREASE or ADDITION in knowledge or skill) *is not* necessary in order for us to say that learning has occurred. When we learn, our way of "seeing" things or our way of doing things is always _____ed (whether this turns out to be an improvement or not).

6. We use CHANGE in *behavior* as an indication of learning in others, because there

seems to be no sure way of telling that a change has occurred in the way another person "sees" a situation, except by observing a change in his _____.

7. From our observation and study of the BEHAVIOR or ACTIONS of others (including verbal behavior—speech and writing), we may infer the workings of their "minds." However, most modern psychologists talk and write more about *behavior* than about "minds." In this respect most modern psychologists are _____ists.

8. One definition of a BEHAVIORist is "a psychologist who defines psychology as the science of the *behavior* of *organisms*." The modern science of _____ studies the behavior of man and of other animals, using the same general methods.

9. Although the word "mind" does not occur with great frequency in recent PSYCHOLOGY texts, psychology still is (as Webster's *Dictionary* puts it) "The science which deals with the _____ in all of its aspects."

* * *

SUMMARY

25. The DEFINITIONS we have given of "behaviorist" and "learning" are *operational definitions*. We defined a "behaviorist" as "a psychologist who defines psychology as the science of the _____ of organisms."

Cragun, John (C) CRP

Introductory Psychology. Logan: Utah State University. (Based on "Feeling and Emotion" in *Introduction to Psychology*, by Clifford T. Morgan. New York: McGraw-Hill Book Co., 1956.) Copies of this program are not available. Length, 9 chapters of text.

Instructions: This tape is designed to serve as a study aid in understanding and mastering the information on "Feeling and Emotion" contained in Chapter 4. There are a total of 100 items on the chapter and they have been divided into two parts. The first part (Part 1) consists of 60 items and the second part (Part 2) consists of 40 items. About 100 minutes will be required to complete the 100 items. (Note: follow up amplification of the answers.)

Each item consists of three parts: (1) the question, usually of a short answer type, (2) the answer to the question, and (3) a discussion of the question including a page reference.

The tape will move only one way, while in the machine. Therefore, if you desire to do further study on any topic, it will be necessary for you to take any desired notes on the topic or page reference at the time the item appears in the window. The textbook may be used in connection with this tape. (Note: to answer many of the questions below you may have to use a phrase.)

1. About the only emotion that can be distinguished in the first few weeks after birth is _____.

   diffused general excitement

   This general excitement is about the same from one occasion to the next; it is not a specific response to any particular stimulus; it shows itself whenever the environment suddenly changes. (p. 87)

2. What is the earliest age at which a child generally can respond differently to pleasant and unpleasant experiences?

   three months

At three months he responds to unpleasant situations with general signs of distress, but he responds to nursing, fondling, tickling, and rocking with smiling and general signs of delight. (p. 87)

3. Once a child begins to make a distinction between pleasant and unpleasant experiences the emotions begin rapidly to differentiate, and by _____ (give age) he has a repertory of specific reactions to different situations.

   two years (see p. 87)

4. Before any diversity of emotional reactions can be fully developed, it is necessary that there must be control of muscles of the face, the vocal apparatus, and the body. All this then, it would seem, would depend upon the maturation of the _____.

   nervous system

   The control of the facial muscles, the body, and the vocal apparatus are dependent upon the nervous system. This is one reason why it is felt that maturation plays an important part in emotional development. (p. 88)

Ellison, Faye S.; Welsh, Ralph S.; and Della-Piana, Gabriel (C) CRP

An Introduction to Counseling. Salt Lake City: University of Utah, 1959. Copies of this program are not available. Length, 8 lessons, 35 frames per lesson (280 frames).

1. In the formulation of the wording of an "understanding" response, it is possible to communicate a _____ attitude than that intended.

   different

2. There are _____ (number) types of errors which may occur in attempting an understanding _____.

   four (4) *response*

3. Some errors possible in attempting a(n) _____ response are errors in Content, Language, Depth, and Meaning.

   understanding

4. A counselor's _____ which merely repeats the client's words is a response inappropriate in Content. To simply *repeat* the client's words does not adequately reflect his feeling and perception. Nor does it communicate the attitude "Do I understand you correctly?"

   response

5. Client: "I feel like a failure"; Counselor: "You feel like a failure." The counselor's response exemplifies a(n) _____ error, because he merely repeats part of the client's statement. This is _____ a good understanding response.

   content *not*

6. Responding only to the content of what a client has said, as in simply repeating his words, will not accurately convey _____ of the client and his feelings.

   understanding (acceptance)

7. An understanding response should reflect the "feeling" and "perceptual" aspect of what the _____ is saying, not merely the word content.

   client

8. A content error in attempting an understanding response means that the counselor is reflecting the _____ of what the client has said rather than the _____ implied in his communication.

   content *feeling (perception)*

9. If a counselor, in attempting to make an "understanding" response, merely reorders the words of the client, this response is likely to be inaccurate in _____, i.e., the response would be to *word* content, not *feeling* content.

   content

Holland, James, and Skinner, B. F. (C) CRP

The Analysis of Behavior. Cambridge: Harvard University. Published by McGraw-Hill Book Company, copyright 1961. Programmed textbook, $3.50. (This will be followed by a teaching machine format.)

(The number of words needed to complete an item is indicated by the number of blanks. Thus "_____" indicates a one-word response, whereas "_____ _____" indicates a two-word response. When asterisks (* * *) are used in place of blanks, the number of words to be filled in is left indefinite. In this case, the number can be one or more.)

1. A stimulus which follows a response is called a(n) _____ if the rate at which similar responses are emitted is observed to increase.

   reinforcer (reinforcing stimulus)

2. A hungry pigeon pecks a key and is immediately given food. The (1) _____ of the pecking response will increase, since presenting food (2) * * * a reinforcement.

   (1) rate (frequency) *(2) is (constitutes, acts as)*

3. If, instead of presenting food after the pigeon pecks the key, a loud noise is turned *on*, the rate of pecking will *not* increase. Presenting a loud noise * * * a reinforcement.

   is not

4. When pecking a key *turns off* a very loud noise for a few moments, frequency of pecking in the presence of the noise may be observed to *increase*. In that case ending the loud noise * * * a reinforcement.

   is

5. Reinforcement which consists of *presenting* stimuli (e.g., food) is called *positive* reinforcement. In contrast, reinforcement which consists of *terminating* stimuli (e.g., painful stimuli) is called _____ reinforcement.

   negative

6. Turning off a television commercial is reinforced by the termination of a(n) (1) _____ reinforcer; turning on a very funny program is reinforced by the presentation of a(n) (2) _____ reinforcer.

   (1) negative *(2) positive*

7. A stimulus is called a negative reinforcer if its _____-tion reinforces behavior.

   termina[tion] *elimina*[tion]

8. Elimination of a television commercial may be a negative reinforcement. If so, the television commercial is a(n) _____ reinforce- _____.

   negative [reinforce]*r*

9. If a funny program is a positive reinforcer, presenting the program is a(n) _____ _____.

   positive reinforcement

10. The rate of an operant can be increased by presenting a(n) (1) _____ _____ or by ending a(n) (2) _____ _____.

    (1) positive reinforcer (2) negative reinforcer

Lundin, Robert; Stebbins, William; and Geis, George (C) CRP

Introductory Psychology. Clinton, New York: Psychology Department, Hamilton College (under a grant from The Fund for the Advancement of Education). Project director, Charles Goodcharles. Copies of this program are not yet available. Length, 6000 frames.

PANEL D-18-2

An Illustration of Mediated Generalization

In this experiment, the galvanic skin response (GSR) was recorded for a series of words. Then one group of words (called "stimulus words") was conditioned respondent-wise, by pairing shock with the visual exposure of the word. Then the stimulus words, homonyms, synonyms, and antonyms were exposed to the subject in random order. The percent increase in GSR between pre-conditioning and post-conditioning GSR was recorded. Average percent increase is shown in Table I.

TABLE I

	7 yrs. 9 mos.	10 yrs. 8 mos.	14 yrs.	18 yrs. 6 mos.
Number of subjects	21	22	25	24
Stimulus word	222	227	243	281
Homonym	159	65	60	52
Antonym	139	97	77	103
Synonym	129	60	110	149

1. Stimulus equivalence which results from training is the basis of a mediated generalization. Thus, when you say the word URN and the word VASE "mean the same thing," you are demonstrating _____ generalization.

   mediated

   (Read through Panel D-18-2 before going on to the next items)

2. (Refer to Panel D-18-2.) The greatest GSR for all groups was recorded for the _____ word.

   stimulus

3. (Refer to Panel D-18-2.) The GSR to *homonyms* is seen to be the strongest in the age group _____ yrs. _____ mos.

   7 yrs. 9 mos.

4. (Refer to Panel D-18-2.) For the older subjects the second greatest GSR was given for *(synonyms, antonyms, homonyms).*

synonyms

5. Generalization to homonyms would be an example of _____ generalization.

stimulus

6. Generalization to synonyms would be an example of _____ generalization.

mediated

Meyers, C. E., and Fry, Edward B. (C) CRP

Educational Psychology. Los Angeles: Specialist Teacher Project, School of Education, University of Southern California. Copies of this program are not available. Length, 1000 items.

35. An important type of reinforcement is "knowledge of results" in which a student is told immediately after a response if he was right or _____.

wrong

36. Then by telling a student how he is doing, the teacher is giving knowledge of _____.

results

37. Then knowledge of results, particularly if the student made a correct response, is also R_____.

reinforcing or rewarding

38. Giving back a corrected paper provides _____ of results.

knowledge

39. If knowledge of results is reinforcing, it can be said to aid L_____.

learning

40. If a machine (heater) is told by a sensory instrument (thermostat), engineers would call the process feedback, but it is the same or knowledge of _____.

results

41. Some psychologists and educators, then, are interested in the amount of knowledge of results or F_____ in the learning situation.

feedback

42. When those interested in feedback look into most teaching situations in school, college, and industry, they find relatively little and thus conclude that L_____ is not occurring with maximum efficiency.

learning

43. Some students have further shown that the more immediate the feedback the better the learning and the more delayed, the _____.

worse

44. One of the benefits of this type of teaching which you are being exposed to up to this moment is the immediacy of the F_____.

feedback

45. Feedback may be one of the reasons that both positive and _____ reinforcement cause learning.

negative

Pressey, Sidney L. (C) MCP

Educational Psychology. Columbus: Ohio State University. Available only to qualified researchers. Length, approximately 50 auto-instructional sheets.

(This material is the first part of a 30-item auto-instructional exercise attempting to improve judgment as regards issues in the reading of a first course in educational psychology. It was set for use with the drum tutor or punchboard, but could have been used with the chemo card. See page 36; also *Teaching Machines and Programmed Learning*, edited by A. A. Lumsdaine and Robert Glaser, p. 70-72, 87-89, 98-90.)

THE GROWTH OF ATTITUDES AND OF MORAL AND AESTHETIC STANDARDS (P9 JL)

Directions: Read the following statements and evaluate each as follows: Press key A (or punch position A) if you think the statement is extreme and goes beyond best evidence or understanding regarding the topic; key B if the statement is true, according to present knowledge or understanding regarding the topic; key C if the statement is uncertain, so far as present knowledge or theory is concerned; key D if the statement is false, according to best evidence or theory.

A—Extreme C—Uncertain
B—True D—False

1. Schools have been used to instill the ideas and ideals of political groups.
2. In general, prejudice among children decreases with advancing age and maturity.
3. Children now acquire strong and effective ideals as embodied in historical characters through study in school.
4. Adolescents, given relatively more freedom at home, rely less wisely on their own judgment than those under more parental control.
5. Health may be an important factor in the formation of attitudes.
6. Culture is the most important and most subtle of all determinants of attitude.
7. Printed matter is the most effective medium used in influencing opinion.
8. Artistically inferior children are less intelligent than those artistically superior; dullness and poor taste always go together.
9. Adolescence always brings on crises in ideals and conduct.
10. Talks, obviously propagandist in purpose, often noticeably affect the attitudes of intelligent and critical individuals.

Pressey, Sidney L. (C) MCP

Nature and Nurture of Abilities. Columbus: Ohio State University. Available only to qualified researchers. Length, approximately 50 auto-instructional sheets.

(This is the first part of a 30-item auto-instructional exercise in interpretation of brief case studies, to be used with the chemo card as described on page 36, or the punchboard. Like all auto-instructional exercises supplemental to reading tried in 1945-50, it was used in an informal laboratory situation fostering small-group discussion. Most of the exercises were more conventional four-choice items.)

Jimmy was 10 years old. His idea of fun seemed to be interference with the play of others. In class he would ignore directions and proceeded to do things in his own way.

On a Binet test he made an IQ of 71. However, on those few test items touching farm situations he did well. The school psychologist learned that Jimmy had been raised in an isolated rural environment and in a harshly autocratic home. He had never been in a store until moving to town, had never been to a party, had never played games, but had ridden horses and run trap lines, clubbing wild animals to death.

* * *

1. The psychologists decided that the intelligence test results were: (a) a fairly good indication of Jimmy's mental capacity; (b) typical of children from rural communities; (c) misleading and should receive no attention; (d) rough indication of his general ability at the time.
2. Although inadequate, which method of appraising abilities should be most informative in this case: (a) individual interview scales; (b) rating schemes; (c) group tests; (d) special aptitude tests.
3. Why? (a) they are easiest; (b) they uncover emotional distraction; (c) the examiner can estimate the degree of his attention and the suitability of the test questions for him; (d) the examiner can allow in his scoring for Jimmy's limited experience.
4. The test scores were a poor appraisal of Jimmy's mental capacity because: (a) he had had little experience with tests; (b) much test material was not from his everyday experience; (c) he was emotionally upset; (d) his schooling was inadequate.
5. Jimmy's playground behavior might best be improved by: (a) giving him opportunities, in supervised play, to make good with the other children; (b) giving him special training alone; (c) letting him play with children of lower mental ability; (d) letting him learn the "hard way" from other children.
6. The most practical method to increase Jimmy's IQ would be: (a) making him do intensive school work; (b) helping him gain a background of experience similar to his mates; (c) providing him with love and sympathy to make up for what he missed at home; (d) putting him in a good home for the mentally deficient.
7. Jimmy's difficulties with other children seemed due most to: (a) his dislike of them; (b) emotional distractions; (c) poor health; (d) lack of information and experience in group activities.
8. Since Jimmy came from a poor socio-economic environment: (a) the chances are that he is feeble-minded; (b) probably his actual mental capacity is average; (c) his mental ability may be low, but no assumption should be made till he has a chance to develop his potentialities; (d) no inference can be made concerning his mental ability.

Smith, Edgar (C) CRP

Scoring of the "Primary Mental Abilities Test." Devon, Pennsylvania: The Devereux Foundation. Available only to qualified researchers. Length, one 8½"x28" page.

General Instructions: To complete this task, you will need the following material: (1) Answer Pad for the SRA Primary Mental Abilities Test for "CG" dated May 5, 1960. Make no marks on this answer pad. In counting answers, record results on scratch pad initially. These responses are based on an actual case and are typical of ones you may anticipate obtaining in an actual testing. (2) Blank interpretation folder to be filled out as you proceed. (3) Manual for PMA 7-11. (4) Pencil.

1. The number of X's within the circles is the raw score for Verbal-words (Vw). This raw score is _____.

   24

2. Counting the X's in the squares gives the raw score for Verbal-picture (Vp). This is _____.

   24

3. The raw score for V is found by adding that of Vw to _____. The raw score for Verbal is _____.

   Vp 48

4. The raw score for Space (S) is _____.

   15

5. The raw score for Reasoning-words (Rw) is _____.

   24

6. The raw score for Reasoning-figures (Rf) is _____.

   18

7. The raw score for Reasoning (R) is found by adding _____.

   Rw and Rf (42)

   On the Perceptual speed (P) test, both answers must be correct to get 1 credit. In this case the first item is wrong, the second is correct giving a score of 1, the third is only half correct and is not counted. Total score for these three items is 1.

8. The raw score for Perceptual speed (P) is _____.

   21

   Responses for Numbers (N) are found written in the boxes, the correct answer is printed in the lower right hand corner of each box. Count each row, then add the rows together to get the total (remember not to mark the answer pad given you, though in actual administration you would write directly on it).

9. The raw score for Numbers (N) is _____.

   35

■ RELIGION

Barbour, Hugh (C) CRP

The Old Testament. Richmond, Indiana: Earlham College. Project coordinator, John A. Barlow. Copyright 1961, Hugh Barbour. Available only to qualified researchers. Length, 464 items.

General Information. The Questionnaires are meant to help in the actual reading of the Bible. If they do not help the student, they have no point. Each Questionnaire consists of a series of Old Testament passages, with questions on each (as in the dull, old-fashioned type of Sunday-school lessons). The passages are mainly from the specific Bible book which is the subject of lectures and discussion the same week. The passages chosen for each Questionnaire usually also involve a single problem of reading or interpretation to be worked through: these are explained in the Introductions to each Questionnaire. The answers to the questions are usually

clear from the Bible passage being studied, but may need careful thought. (Answers found in a textbook, or by looking ahead in the questionnaire, are not "wrong"—this is not a quiz—but are stupid, as they skip over the study of the Bible itself.)

QUESTIONNAIRE III: THE RELIGION OF DAVID

Part III-A: Read through the story in II Samuel *6:*— in your Bibles.

1. Around what object does the story in II Samuel *6:*— center?

   The Ark of God (or Ark of the Covenant of the Lord: the word "Ark" means a box. Don't confuse this with Noah's Ark.)

2. Who originated the Ark, and where? (cf. Numbers *10:* 33-36)

   Moses brought it with the Hebrews from Mount Sinai.

3. What did the Ark symbolize for the Hebrews?

   The presence of Yahweh. (It also symbolized the Covenant, but if there were stones in the Ark they stood for the mountain where God lived, just as much as they stood for the commandments God gave.)

4. Why is David described in II Samuel *6:*5 as being "before the Lord" while he was making merry?

   He was in front of the Ark: ("The Lord" is Yahweh, who is here thought of as actually living in the Ark.)

5. In verse 14, where does David dance?

   In front of the Ark.

6. Where had David intended to take the Ark? *(6:*10)

   To the City of David (Jerusalem): cf. II Samuel *5:*7.

7. Why is Jerusalem called the City of David in this story? (cf. Ch. *5:*—)

   He had just captured it (5:7); David now lived there: (5:9)

8. Who had been the previous inhabitants of Jerusalem? (cf. II Samuel *5:*6)

   Jebusites (a Canaanite group)

■ RUSSIAN

Pressey, Sidney L. (C) Special MCP

Russian. Columbus: Ohio State University. Available only to qualified researchers. Length, 1 page (of some 20 experimental auto-instructional exercises for trial purposes).

(This auto-instructional exercise was used with a two-choice form of the chemo card or punchboard, following five minutes study of a 30-word Russian-English vocabulary list. This 30-item test includes each Russian word twice in association with its meaning but the second time in a different context, the easy problem being only to pair up correctly two Russian with two English meanings. Each response was thus in effect a double confirmation.)

(Student responds on a punchboard and matches first word with A or B. Punchboard tells student if match is correct. When correct match is found, student knows that last Russian word matches the other English choice.)

1. *moloko:* (a) milk; (b) much: *mnogo*
2. *platok:* (a) breakfast; (b) kerchief: *zavtrak*
3. *glubina:* (a) depth; (b) expensive: *dorogo*
4. *zapiska:* (a) note; (b) armchair: *kreslo*
5. *slovo:* (a) word; (b) pencil: *karandash*
6. *potom:* (a) trip; (b) then: *poiezdka*
7. *most:* (a) bridge; (b) place: *mesto*
8. *zapad:* (a) paper; (b) west: *bumaga*
9. *tarelka:* (a) plate; (b) never: *nikogda*
10. *isba:* (a) seven; (b) hut: *sem*
11. *kniga:* (a) book; (b) kerchief: *platok*
12. *stakan:* (a) milk; (b) glass: *moloko*
13. *sem:* (a) note; (b) seven: *zapiska*
14. *golova:* (a) head; (b) salesman: *prodavets*
15. *bumaga:* (a) then; (b) paper: *potom*
16. *polovina:* (a) thought; (b) head: *duma*
17. *poiezdka:* (a) west; (b) trip: *zapad*
18. *razgovor:* (a) conversation; (b) water: *voda*
19. *kreslo:* (a) hut; (b) armchair: *isba*
20. *krasivo:* (a) beautifully; (b) cow: *korova*
21. *zavtrak:* (a) glass; (b) breakfast: *stakan*
22. *prodavets:* (a) salesman; (b) book: *kniga*
23. *mnogo:* (a) head; (b) much: *golova*
24. *duma:* (a) plate; (b) thought: *tarelka*
25. *dorogo:* (a) expensive; (b) half: *polovina*
26. *voda:* (a) water; (b) bridge: *most*
27. *karandash:* (a) conversation; (b) pencil: *razgovor*
28. *korova:* (a) cow; (b) word: *slovo*

Saltzman, Irving J. (S, C, A) CRP

Russian Alphabet. Bloomington: Indiana University. Copyright 1960, Irving J. Saltzman. Copies of this program are not available. Length, 2500 frames (8 hours).

Eleven programmed pamphlets are required to teach the complete alphabet. Each pamphlet consists of approximately 200 frames and teaches the student the names of three of the letters, what they look like in print, and how to write them in script, both small letters and capitals. A twelfth pamphlet requires the student to copy, in script, some printed Russian statements.

Two kinds of frames are used, statement-frames and problem-frames. Each statement-frame is followed by a series of problem-frames. No response is required with the statement-frames; problem-frames require constructed responses as well as multiple-choice selections. The separation of statement-frames from

problem-frames allows for the review of material already studied as well as for the preview of material about to be studied.

St. 29. The next letter in the Russian alphabet after the Russian letter "deh" is the Russian letter "yeh."

29-1. Does the Russian letter "yeh" immediately follow the Russian letter "deh" in the Russian alphabet?

yes

29-2. Is the letter which comes just before the letter "yeh" in the Russian alphabet called "deh" or "gheh"?

"deh"

29-5. What is the name of the letter which comes just after the Russian letter "deh" in the Russian alphabet?

"yeh"

St. 30. The Russian *capital* letter "yeh" is *printed* as follows: E. You will notice that it is exactly like the English letter E. You may have difficulty, therefore, remembering that the Russian name for this letter E is "yeh," not "ee."

30-1. Which of the following is the correct way to print the Russian capital letter "yeh": "E" or "Y"?

"E"

30-4. What is the name of the following Russian letter: "E"?

"yeh"

35-7. What are the names of the first six letters in the Russian alphabet?

"ah," "beh," "veh," "gheh," "deh," and *"yeh."*

Weinreich, Marcel I. (S, C, A) CRP

Basic Russian. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1961. Published by TMI-Grolier, programmed textbook and machine format, $10. Length, 2000 frames.

1. The Russian sound: spaSEEbo* ← (These mean COPY the words)
   Means: thanks* ← (Capital letters show accented syllables)

   spaSEEbo thanks

2. Russian sound: spaSEEbo
   Means: _____

   thanks

3. The "a" in "spaSEEbo" is sounded "ah," like the "a" in "father." Therefore, the "a" in "spaSEEbo" *and* "father" is sounded _____.

   ah

4. Russian sound: spaSEE ___
   Means: thanks

   bo

5. The "o" in "spaSEEbo" is sounded somewhat like the "aw" in "crawl." Therefore, "bo" is sounded _____.

   baw

6. The "a" in "spaSEEbo" sounds like the ____ in "father."
The "o" in "spaSEEbo" sounds like the ____ in "bawl."

a aw

7. Russian sound: spa _____
Means: thanks

spa [*SEEbo*]

8. Russian sound: _____
Means: thanks

spaSEEbo

9. Russian sound: OOtro* ← (COPY) (Accent the big letters. "OO" sounds like 'oo' in "boot.")
Means: morning* ←

OOtro morning

10. Russian sound: OOtro
Means: _____

morning

■ SPANISH

Wilson, Niram A., Jr., and Ventolo, William (S, C, A) CRP

Basic Spanish. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1961. Published by TMI-Grolier, programmed textbook and machine format, $12.50. Length, 3400 frames.

205. Spanish: _____
Means: The sky is blue.

El cielo es azul

206. "j" and "b" are in the word "trabaja" (works). "j" = ____ sound; "b" = soft ____ sound, somewhat like Spanish "v."

h b

207. "baja" is sounded "bah-hah." "trabaja" is sounded _____.

trahbah-hah

208. Spanish: El señor traba ____ ____ ____ ____. (Write entire sentence and fill in what's missing.)
Means: The gentleman works in the city.

El señor traba *(ja en la ciudad)*

209. Spanish: El señor tra____ ____ ____ ____. (Write entire sentence and fill in what's missing.)
Means: The gentleman works in the city.

El señor tra*(baja en la ciudad)*

210. Spanish: El señor ____ ____ ____ ____. (Write entire sentence and fill in what's missing.)
Means: The gentleman works in the city.

El señor *(trabaja en la ciudad)*

211. "ñ" is in the word "señor" (gentleman). "ñ" = _____ sound as in "barnyard."

ny

212. Spanish _____.
Means: The neighbor knocks at the door.

La vecina llama a la puerta

213. "ñor" is sounded "nyohr." "señor" is sounded _____.

sehnyohr

214. Spanish: El se_____ _____ _____ _____ _____. (Write entire sentence and fill in what's missing.)
Means: The gentleman works in the city.

El se*(ñor trabaja en la ciudad)*

215. Spanish: El _____ _____ _____ _____ _____. (Copy entire sentence and fill in what's missing.)
Means: The gentleman works in the city.

El *(señor trabaja en la ciudad)*

216. Spanish: _____ _____ _____ _____ _____ _____.
Means: The gentleman works in the city.

El señor trabaja en la ciudad

■ SPELLING

Evans, James L. (S, C, A) CRP

Introduction to Word Building. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1961. Published by TMI-Grolier, sample program, 25 cents. Length, 19 frames.

1. "TELE" means "at a distance." "SCOPE" means "seeing." An instrument for "seeing things at a distance" is a _____.

telescope

2. Which part of the word TELEscope means "at a distance"? _____

tele

3. Which part of the word TELESCOPE means "seeing"? _____

scope

4. MICRO means "very small." An instrument for "seeing things that are very small" is a _____.

microscope

5. Which part of the word MICROSCOPE means "very small"? _____

micro

6. Now think of the word which means "very small." Add "METER" which means "to measure." It is easy to guess that an instrument for "measuring things that are very small" is a _____.

mī•crom' ĕ•ter

7. What part of the word MICROMETER means "very small"? _____
   What part of the word MICROMETER means "to measure"? _____

   micro meter

8. Astronomers use an instrument for "seeing things at a distance (stars)." It is called a _____.

   telescope

9. Biologists use an instrument for "seeing things that are very small." It is called a _____.

   microscope

10. Physicists use an instrument for "measuring things that are very small." It is called a _____.

    micrometer

11. The part of a word which means "at a distance" is _____.

    tele

12. The part of a word which means "to measure" is _____.

    meter

13. Rockets and satellites have instruments on board to *measure* things. Scientists read these measures *at a distance* by using radio. They needed a new word for an instrument which *measures* things *at a distance*. It is easy to guess that the word they made up is _____.

    telemeter

14. An instrument used to "measure things at a distance" is a _____.

    telemeter

Hoose, I. K. (S) Vanishing CRP

Spelling (Ninth Grade). Ohio: Kent State University. Copyright 1960, I. K. Hoose. Copies of this program are not available. Length, over 300 words.

1. The blood donor remained anonymous. "Anonymous" (adj) can mean unknown. Underline the words, "anonymous."

   anonymous anonymous anonymous

2. "Anonymous" is pronounced *a* $\breve{n}$*on'* $\breve{i}$ *m*$\breve{u}$*s*. Underline spelling letters differing from pronouncing letters.

   y o

3. Divide "anonymous" into syllables. Separate with a "/" line. Underline the vowels.

   a/ n$\underline{o}$*n/ y/ m*$\underline{o}$*us*

4. Write the missing letters: *an — — y — ou —.*

   o n m s

5. Write the missing letters: *a — on — m — — s.*

   n y o u

6. Write the spelling word: _____.

   anonymous

7. The "Boy Scouts of America" is an association. "Association" (n) can mean a group. Underline the words, "association."

   association association association

8. "Association" is pronounced *ă-sō′ si-ā′ shŭn*. Underline the spelling letters differing from pronouncing letters.

   s c tio

9. Divide "association" into syllables. Separate with a "/" line. Underline the vowels.

   as/so/ci/a/tion

10. Write the missing letters: *a–s–ci– –ion*.

    s o a t

11. Write the missing letters: *asso– –at– –n*.

    c i i o

12. Write the spelling word: _____.

    association

Stone, David (C) Special CRP

Spelling (College Level). Logan: Utah State University, May 1960. Available only to qualified researchers. Length, 6 to 9 sessions.

(Based on general spelling rules. Used in connection with tape recorder fixed rate; adequate time allowed.)

1. In this series we want to show you six ways to improve your spelling. On the response sheet, write your name, address, and phone number. DO THIS NOW!

1a. How many ways for spelling improvement will you get in this series? Write your answer on the response sheet and turn lever to space 2.

   six

2. *The first* of these six ways to improve spelling is by the use of phonetics (this is our subject this time, and the other ways will be given in your other hours). What is phonetics? Write your answer.

   the study of sounds and letters

2a. Now, write again—what is phonetics? The first use of phonetics is to note carefully *each* sound in a word. If you miss a sound, you may miss a letter!

   the study of sounds and letters

3. Write the word you hear. (Tape says "accidentally")

3a. Copy what you wrote in space 3. Now write the word you hear on the tape.

   correct spelling is: *accidentally*

4. Observe that the correct pronunciation will aid in spelling words like this. Write the word you hear.

4a. Copy what you wrote in frame 4. Now write what you hear.

   correct spelling is: *exaggerate*

5. If you missed the word, note how the correct pronunciation *could*, or if you got it correct, how did it help you get it correct. *Remember* that the person speaking may

not say the word properly, so IT IS UP TO YOU TO REPEAT THE WORD CAREFULLY TO YOURSELF! What should you do?

repeat the word carefully to myself

5a. *The second use* of phonetics is to note that some letters are not connected to a sound at all—they are silent. Write the word you hear.

debt

5b. Note the silent letter is "b." Now write the word you hear. What is the silent letter?

exhaust "h"

6. We have demonstrated that some letters are _____? (what?)

silent

Ventolo, William (E, S, C, A) CRP

Modern English Spelling. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1961. Published by TMI-Grolier, programmed textbook and machine format, $12.50. Length, 3000 frames.

261. (cut, cute). Which word has the short *u* sound? _____

cut

262. (but, mule). Which word has the long *u* sound? _____

mule

263. (hop, hope). Which word has the short *o* sound? _____

hop

264. (top, close). Which word has the long *o* sound? _____

close

265. If it snows this *week*, we will ride our *sleds*. Which italicized word has the long *e* sound? _____

week

266. Christmas comes in _____

December

267. To move quickly means to _____

hurry

268. If today were Tuesday, tomorrow would be _____

Wednesday

269. To move _____ means to hurry.

quickly

270. If today were Tuesday, _____ would be Wednesday.

tomorrow

271. An *e* added to words _____ the vowel sound from short to long.

changes

272. _____ comes in December.

Christmas

273. An *e* added to words changes the v _ _ _ _ sound from short to long.

owel

274. The word *cap* has the _____ s *c* and *p*.

consonant

275. The word *cap* has the _____ *a*.

vowel

■ STATISTICS

Alexander, Howard W., and Smith, Roland F. (C) CRP

Elementary Statistics. Richmond, Indiana: Earlham College. Project coordinator, John A. Barlow. Published by Earlham College, copyright 1960. Sheet form, $2.50; workbook, $2.75; 4x6 cards, $5. Length, 15 lessons (321 items).

1. Statistics is concerned with observations. There may be either numerical observations or non-numerical observations. For example, measuring the height of each student in a group would give rise to a set of _____ observations. Classifying the workers in a factory according to sex, on the other hand, would give rise to a set of _____ observations.

   numerical *non-numerical*

2. When observations are classified, the classes into which they fall are called *categories*. Thus a classification of the workers in a factory according to sex would use the categories _____ and _____

   male *female*

3. A classification of observations which involves only two categories is called a *dichotomy*. For example, we classify people dichotomously as male and _____, as employed and _____, as native born and _____.

   female *unemployed* *foreign-born*

4. Many dichotomies arise in connection with surveys. A survey might involve asking a group (or sample) of people the question, "Do you prefer a liquid detergent or a powder detergent for dishwashing?" In this case the replies would be classified dichotomously in the categories _____ and _____.

   liquid (detergent) *powder (detergent)*

5. Assuming that all voters in a county will vote either Democratic or Republican, the classification of these voters according to political preference is a _____.

   dichotomy

6. In some investigations we study all possible individuals of a given type; we then say that we are examining the whole *population*. In other investigations we study only a portion, or *sample*, of the population. In most surveys the people interviewed would form only a _____ of the total population; the U.S. census, on the other hand, studies an entire _____.

   sample (portion) *population*

7. Surveys may be concerned with numerical or non-numerical observations. If a survey records the number of children in each family interviewed, then we are dealing with

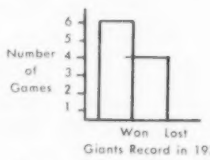
_____ observations. If, on the other hand, a survey records the state of origin of a group of students, we would have _____ observations.

numerical *non-numerical*

Evans, James L.; Homme, Lloyd E.; Glaser, Robert; and Stelter, Charles J. (C, A) CRP

Introductory Statistics. Albuquerque, New Mexico: Teaching Machines, Inc., copyright 1961. Published by TMI-Grolier, programmed textbook and machine format, $10. Length, 1700 frames.

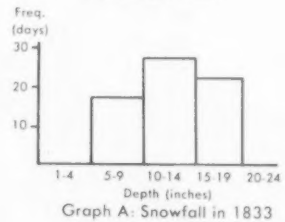
1. A good way to show how often events happen is to use a *graph*. For example, this graph shows that the Giants won 6 games in 1939. It also shows that the Giants lost (#)___games in 1939.



Giants Record in 1939

4

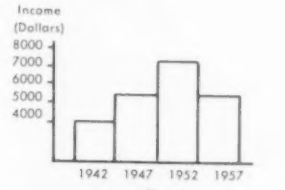
2. Statisticians summarize and describe measures with graphs called "frequency distributions." Since Graph A shows how frequently different amounts of snowfall occurred, it would be called a (wds) ____.



Graph A: Snowfall in 1833

frequency distribution

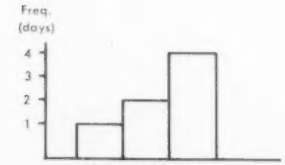
3. Graph B does *not* show how often each amount of farm income occurred; it is *not* a (wds)____.



Graph B: Average Farm Income

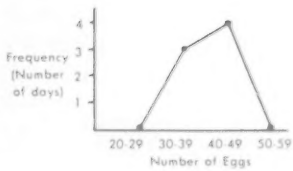
frequency distribution

4. If we use *rectangles* in showing a frequency distribution, we call it a "histogram." For example, this frequency distribution shows how often different numbers of plates were broken in a restaurant one week. Since it uses rectangles, it is a (wd)____.



histogram

5. If we show a frequency distribution by connecting points with lines, we call it a "frequency polygon." For example, this frequency distribution shows how often different numbers of eggs were laid on a chicken farm one week. Since it is made with points connected by lines, it is a (wds) ____.



frequency polygon

6. These two (wds) ____ describe the same data. Figure A is a histogram. Figure B is a frequency polygon. The frequency of occurrence of each amount (depth) of the event (snowfall) is given by the height of the bar in the (wd) ____, or by the height of the point in the (wds) ____. From either, we can see that there were (#) ____ days with 10-14 inches of snow.

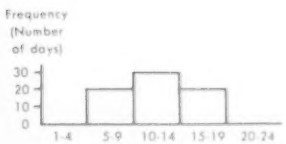


Figure A. Histogram

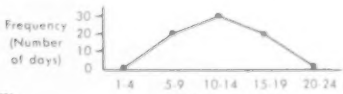


Figure B. Frequency Polygon

frequency distributions, histogram, frequency polygon, 30

7. These frequency distributions show the number of students making different scores on a test. Figure 1 is a (wd) ____; Figure 2 is a (wds) ____. In both cases, we see that a score of 60 occurred 30 times and a score of 80 occurred (#) ____ times.

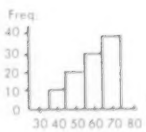


Figure 1

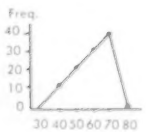


Figure 2

histogram, frequency polygon, 0/zero

8. In frequency distributions we summarize our measurements by *grouping* them. This helps us describe them more easily. In the figure on the right, showing height measurements, we grouped together all heights from 45-49 inches, 50-54 inches, etc. From this (wds) ____, we see that there were 2000 children in the (#) ____ inch group.

frequency polygon, 50-54

Gorow, Frank F. (C) SBP

Do It Yourself Statistics. California: Long Beach State College. Copyright 1960, Frank F. Gorow. To be published in 1962. Part I, 50 items; Part II, 131 items; Part III, 49 items.

PART II—LARGE SAMPLES

81. Copy the Frequency Table and compute Md by following these steps:

N/2 = _____
Counting frequencies up, sub-total is _____
Additional frequencies needed _____
The fraction needed is _____
Correction = i x fraction = _____
Dividing line between groups _____
Md = Dividing line + correction:
Md = ? + ? = _____

Check your results with ₹59.

	f
67-69	1
64-66	1
61-63	7
58-60	4
55-57	10
52-54	24
49-51	14
46-48	9
43-45	12
40-42	10
37-39	2
34-36	2
31-33	4
	100

59. In computing the Median of 100 scores in #81, you should have found: Md = 50.8. If you do NOT have this answer, turn to #79 to check your figures. If you have the correct value, proceed to #56.

56. The Md of the 100 score is 50.8. Mn was previously found to be 49.7. The Md and the Mn will be fairly close together unless the "pull" of the high scores and of the low scores is unequal. We must compute both Md and Mn to determine the tendency to "raise the average" or to lower it. While the "counting" process is fresh in mind, turn to #62.

PART III—MEASURES OF RELATIONSHIP

37. Given: 8 pairs of scores; to compute the Coefficient of Correlation between the two tests. First, complete the x and y columns:

X	*Y*	*x*	*y*
Md = 29.	= 60		
32	68	3	8
24	58	−5	−2
28	60	−1	0
36	65		
30	58		
25	56		
29	60		
28	55		

What do you have for your last two numbers?

1 and 5 — see # 34
−1 and 5 — see #23
1 and −5 — see #4
−1 and −5 — see #16

34. No, you missed! A score *above* the Mn is positive; a number not marked with a sign is a positive number; a score *below* Mn is negative. Return to #37 and check *all* of the signs in your x and y columns.

23. No, you missed! A score *above* the Mn is positive; a number not marked with a sign is a positive number; a score below the Mn is negative. Return to #37 and check *all* of the signs in your x and y columns.

4. No, you missed! A score above the Mean is positive; a number not marked with a sign is a positive number. A score *below* the Mean is negative. Return to #37 and check *all* of the signs in your x and y columns.

16. Right. Deviations of score *below* the Mn are "−" and you have them so marked. We have first 4 columns; they are repeated below. Now, complete the next two columns, x^2 and y^2.

X	Y	x	y	x^2	y^2
32	68	3	8	9	64
24	58	−5	−2		
28	60	−1	0		
36	65	7	5		
30	58	1	−2		
25	56	−4	−4		
29	60	0	0		
28	55	−1	−5		
Mn 29	60			$\Sigma =$	$\Sigma =$

After computing each x^2 and y^2, add the columns, obtaining the quantities Σx^2 and Σy^2. As a check on your accuracy, which pair of sums did you obtain?

102 and 138 — see #2
16 and 40 — see #7
104 and 138 — see #25

Any other sums — better recheck!

Pressey, Sidney L. (C) MCP

Statistics. Columbus: Ohio State University. Available only to qualified researchers. Length, 4 pages.

(Tests devised to lead students through proper steps in calculation of the Median. This is the first part of an auto-instructional practice exercise, used after brief study of a short printed explanation of the median. This exercise was used with the chemo card explained on page 36 or the similar-functioning punchboard. No directions for such use are included, since by the time in the course this exercise was reached, the chemo card or punchboard was thoroughly familiar to the students. Thus by using the chemo card, they knew that they should keep marking until a change in the color of the mark showed them that the right answer had been found.)

CALCULATION OF THE MEDIAN

1. The Measure of Central Tendency found by dividing the sum of the scores by the number of scores is called the (a) mode, (b) percentile, (c) median, (d) mean.

(d)

2. Which of the above refers to the most frequent score?

   (a)

3. If the scores are arranged in order of size, which of the above measures refers to the midpoint of this arrangement?

   (c)

4. Which of the following is abbreviated "M"? (a) median, (b) mean, (c) midpoint, (d) mode.

   (b)

5. Which of the following is abbreviated "Md." or "Med."? (a) median, (b) mode, (c) mean, (d) midpoint.

   (a)

6. The 50th percentile is the same as which of the following? (a) mode, (b) median, (c) mean, (d) norm.

   (b)

Score	Frequency
7	1
6	1
5	2
4	4
3	1
2	1

7. In the distribution at the left, how many persons earned a score of 3? (a) 2, (b) 4, (c) 10, (d) 1.

   (d)

8. The number of cases in this distribution is which of the above?

   (c)

9. The *range* of this distribution is: (a) 5, (b) 10, (c) 7, (d) 4.

   (b)

10. Which of the above is the mode in this distribution?

    (d)

11. In the distribution at the left, to reach the median, we must count up from the bottom how many scores? (a) 4, (b) 10, (c) 5, (d) 13.5.

    (c)

12. Thus we know that the median is at least which of the above scores?

    (a)

13. How many of the total frequencies in the step interval containing the median must we include to reach the median? (a) 1, (b) 4, (c) 2, (d) 3.

    (d)

14. We must next divide this number by the total number of frequencies in this interval. This will give us: (a) .25, (b) .3, (c) .5, (d) .75.

    (d)

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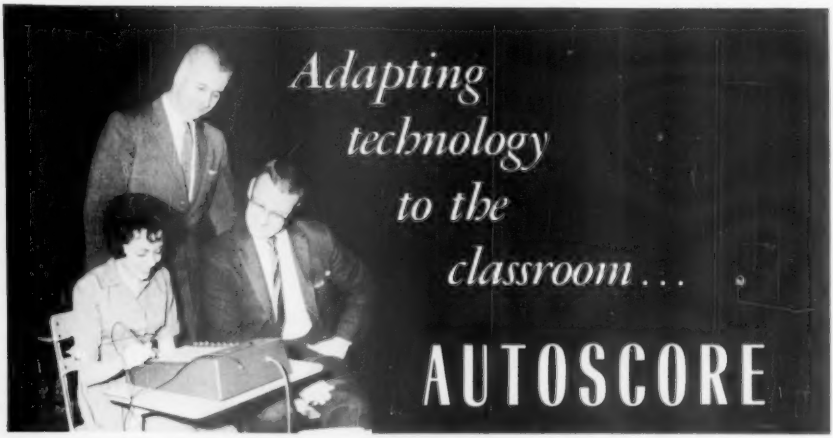

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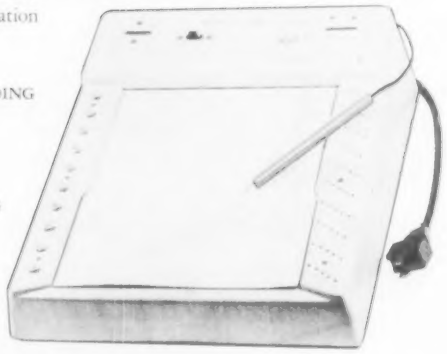

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HOW CLOSE ARE WE TO TEACHING MACHINES IN THE CLASSROOM?

A Special Report on TMI-GROLIER Programed Courses, Programed Texts and Low-Cost Teaching Machines

THE DEVELOPMENT of programed learning has progressed to the point where teachers and educators everywhere are asking how this new instructional method will affect them, their schools, and their classes.

TMI-GROLIER, a pioneer in programing research and teaching machines, has engaged in extensive experimentation, under the leadership of educators and psychologists headed by Dr. Lloyd E. Homme and Dr. James L. Evans.

Working closely with other psychologists in the field, and drawing on the best practical and theoretical experience available, TMI-GROLIER has produced a series of programed courses and texts. In addition, we have perfected and are manufacturing the first practical low-cost teaching machine for use with programed courses.

The TMI-GROLIER programed courses and texts include spelling, arithmetic, algebra, punctuation, music; basic courses in Spanish, French, German, Latin and Russian, and others. Every course has been extensively tested, together with the TMI-GROLIER teaching machine, in actual classrooms. Feedback data are incorporated in the final revisions of every course.

"Teaching machines, *properly programed and properly used*, are our best hope for education."

This statement, by Professor James McClellan of Teachers College, Columbia University, perfectly summarizes the aspirations of TMI-GROLIER.

We do not pretend to know all the answers to programed learning. However, with the cooperation of leading educators, curriculum specialists, and psychologists, we have successfully completed the first necessary steps of this great educational experiment: we have produced a series of thoroughly tested programed courses and texts; we are now manufacturing in quantity the first practical, low-cost teaching machines for educators who want to test them.

Our next step is clearly one in which TMI-GROLIER must explore, together with the educators in the nation's schools, the best possible means for *utilizing* the courses and machines we now have, and others which are in preparation.

Together, we will find the answers to many questions: In what aspects of learning can teaching machines be of optimum use? How effective are they in the classroom? For the individual student? For the teacher? To what extent should administrators and boards of education consider teaching machines?

In this second phase of development, TMI-GROLIER is now at work, correlating our findings with those of others in the educational world. Our courses are constantly being revised and re-designed to meet the actual needs of the teacher and classroom. Our full-scale Programing Facilities are coordinated with the mainstream of leading educational thinking. In short, today's classroom needs and findings are determining the direction of TMI-GROLIER's expanding services in the field of programed learning.

If you wish to know more about TMI-GROLIER's low-cost teaching machines and programed courses, and how you can efficiently test and evaluate them, simply write on your school letterhead to Dept. 63.

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